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OZONE CONCENTRATION BY LATITUDE, ALTITUDE, AND MONTH, NEAR 80° W

by

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Prepared for:

U.S. DEPARTMENT OF TRANSPORTATION
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16. Abstract

To provide a convenient summary of presently available data on ozone concentrations, monthly and seasonal means and standard deviations of ozone are presented in latitude-height cross-sections and tables. Results are given in each of two units: micrograms per cubic meter, and parts per million by volume. Data are based on North American ozonesonde stations, 1962-75.

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INTRODUCTION

To provide a convenient reference for those concerned with ozone concentrations at aircraft flight altitudes, this compilation of ozone concentration as a function of altitude, latitude, month and season is presented in units of parts per million by volume and micrograms per cubic meter. These sections update those previously available in the literature given in other units:

Hering and Borden (1965a), micrograms per cubic meter, data for 1963-64.

Wu (1973), molecules per cubic meter, data for 1963-65.

Wilcox, et al. (1975, 1977), molecules per cubic meter, data for 1963-74.

This summary has additional data over the last reference, but the analysis in molecules per cubic meter would not have changed. The charts here cannot be compared to the earlier ones because of the different units.

There are as many as six units for ozone concentration, five of which are in common use today for different applications: aeronomy, atmospheric physics, atmospheric dynamics and pollution monitoring. In addition, many users retain certain units from habit, although others may serve as well. To help alleviate the confusion, Table 1 gives conversion factors from any one to any other.

DATA

The Air Force Cambridge Research Laboratories conducted a program of quasi-weekly soundings at 14 stations in North America from January 1963 through December 1965 (Hering, 1964; Hering and Borden, 1964, 1965b, 1967). The Regener (chemiluminescent) sonde was used for this series. Following this program, several of these stations continued making soundings mainly with the Brewer-Mast (electrochemical) sonde. The AFCRL and subsequent data through May 1969 were obtained from the World Data Center - A (Meteorology), Asheville, North Carolina. A separate sounding program was conducted at Boulder, Colorado, from 1963 to 1966. These data were

extracted from Dütsch (1966) and Dütsch, et al. (1970) and punched on cards. All remaining data used in this study were obtained from the World Data Center for Ozone, Toronto. Figure 1 and Table 2 show all stations used, their locations, heights, total ascents, periods of record, and principal sonde type(s) used.

Ozonesonde data are calibrated to obtain agreement of the integrated vertical distribution, plus an allowance for ozone above the burst height, with a nearby Dobson total ozone measurement. Following the AFCRL program, the Regener instrument was shown to be subject to substantial inaccuracies due to pump inefficiency at high altitudes. Dütsch (1974), however, notes that "the biggest relative uncertainty in climatological values obtained from sounding programs must be expected at the flight top in the middle stratosphere (i.e., around 10 mb and above) where errors may be on the order of 10%."

COMPUTATIONS

A typical AFCRL sounding contained ozone partial pressure and mixing ratio, as well as temperature and total pressure, every 300 feet or so. For each sounding, the ozone data were linearly interpolated on a log pressure scale to the standard pressures 900, 700, 500, 300, 200, 150, 100, 70, 50, 30, 20, 10, and 7 mb. The "Toronto" data contained ozone partial pressure (and temperature and wind) at the standard pressure levels mentioned above as well as at various "significant" pressure levels. The Boulder data were given as partial pressure at the standard levels. Data from Boulder were merged with that from Fort Collins, about 75 km away.

For each station, all observations for a given calendar month for all years were averaged together as there were small interannual differences in number of soundings per month. Standard deviations were also computed in this manner.

In the figures, ozone was plotted at the altitude of the pressure surface, as a function of latitude and season, according to the U. S. Standard Atmosphere Supplement, 1966. Therefore, height is the true ordinate, and the pressure scale shown is only approximate (annual mid-latitude average).

Seasonal means and standard deviations were computed in the same manner as the monthly means. All tabulated values are read from the analyzed, smoothed graphs.

ANALYSIS

It is well known that there is large longitudinal variability in both total ozone and its vertical distribution. Therefore, true "zonal mean" latitude-height sections of ozone cannot be made from the few widely separated land-based stations. As a first approximation, the analyses are restricted here to eastern North America (~80°W) where latitudinal coverage is best. Some western North American stations were also consulted (Seattle, Albuquerque, Fort Collins/Boulder, and Fairbanks). These stations typically had lower means than those nearer the center of the eastern North America ozone ridge (Wilcox, et al., 1977), and so were given little weight in the analysis.

There was also significant apparent small-scale variability in latitude near 80°W. This was probably due to longitudinal or period-or-record differences, rather than to true latitudinal variability. Where choices had to be made, stations were weighted by number of observations.

The standard deviations were more difficult to analyze than the means because of increased variability between stations. Note that these are standard deviations from the long-term monthly mean at stations and so include interannual variability as well as periodic variations (annual and semi-annual). However, there is no contribution from spatial variability.

The standard deviations given here are <u>not</u> to be confused with the standard error of the mean. The standard error, whose computation is outside the scope of the present work, is a measure of confidence in the mean values. It is normally given by $\sigma_T = \sigma/\sqrt{n}$, where σ is the standard deviation of the individual observations and n is the number of independent observations. The question of independence, both temporal and spatial, is not yet sufficiently resolved.

As to the relative uncertainty within the cross-sections and tables, the analysis above 25 km is less certain than below, due to decreasing numbers of observations. For several station-months, fewer than five sondes reached the highest levels, so any statistics are unreliable. Furthermore, in some months at a few stations, especially in winter at high latitudes, no sondes reached the highest two levels. Such areas are indicated by shading on the charts. In high-latitude, high-altitude regions, the PPMV values still apparently increase upward, and the danger of gross error in extrapolation seems significant. Therefore, on the PPMV cross-sections, these regions have been generally left blank.

A striking peculiarity in the standard deviations is the relative minimum at high altitudes at Grand Turk and the maximum at the Canal Zone. Lacking nearby stations or any reason to choose between stations, and because the feature is so persistent, it was retained. Note, however, that although the observation series at the two stations are concurrent, there were only 10 or so observations per month.

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Table 1. Ozone units conversion factors. Multiply "FROM" units by this factor to get "TO" units. All temperatures are in deg K and all pressures in millibars.

"TO"

"FROM"	μgm^{-3}	10^{-3} cm STP km^{-1}	molec cm^{-3}	μgg^{-1}	μmb	PPMV
μgm^{-3} ("gamma")	1	.0467	$.126 \times 10^{11}$	$\frac{2.87 \times 10^{-3}\ T}{p}$	$1.73 \times 10^{-3}\ T$	$\frac{1.73 \times 10^{-3}\ T}{p}$
10^{-3} cm STP km^{-1}	21.4	1	2.69×10^{11}	$\frac{.0614\ T}{p}$	$.0370\ T$	$\frac{.0370\ T}{p}$
molecules cm^{-3}	7.97×10^{-11}	0.372×10^{-11}	1	$\frac{2.29 \times 10^{-13}\ T}{p}$	$1.38 \times 10^{-13}\ T$	$\frac{1.38 \times 10^{-13}\ T}{p}$
μgg^{-1}	$\frac{348.\ p}{T}$	$\frac{16.3\ p}{T}$	$\frac{4.37 \times 10^{12}\ p}{T}$	1	$.603\ p$	.603
μmb	$\frac{578.}{T}$	$\frac{27.0}{T}$	$\frac{7.25 \times 10^{12}}{T}$	$\frac{1.66}{p}$	1	$\frac{1}{p}$
Parts per million by volume (PPMV)	$\frac{578.\ p}{T}$	$\frac{27.0\ p}{T}$	$\frac{7.25 \times 10^{12}\ p}{T}$	1.66	p	1

TABLE 2

Ozonesonde Stations

Stations	Lat.	Long.	Station Elev(m)	Period of Record	Total Ascents	Instrument Type*
Thule	76.5N	68.8W	11	01/63-01/66	92	R
Resolute	74.7N	95.0W	64	01/66-12/75	441	M
Fairbanks	64.8N	147.9W	138	01 63-12/65	107	R,CI
Churchill	58.8N	94.1W	35	01 63-12/65	100	R
Goose Bay	53.3N	60.4W	44	01/63-05/69	207	R,M
Seattle	47.4N	122.3W	137	01/63-12/65	148	R
Madison	43.1N	89.4W	264	01/63-12/65	83	R
Bedford	42.5N	71.3W	80	12/62-03/71	586	M,R
Ft. Collins	40.6N	105.1W	1551	01/63-06/67	209	R
Boulder	40.0N	105.2W	1652	08/63-07/66	494	M
Sterling	39.0N	77.5W	84	08/62-06/66	179	R,CI,M
Wallops Is.	37.8N	75.5W	3	02/67-04/75	223	M
Albuquerque	35.0N	106.6W	1573	01/63-12/65	208	R
Tallahassee	30.4N	84.3W	53	01/63-12/65	138	R
Cape Kennedy	28.4N	80.5W	2	02/66-05/69	135	M
Grand Turk	21.5N	71.1W	10	12/63-05/69	129	M,R
Canal Zone	9.0N	79.6W	9	01/63-05/69	126	R,M

*Instrument types are in decreasing order of number of ascents; only instruments used for more than 10% of the ascents are included. M=Brewer-Mast; R=Regener; CI=Carbon-Iodide.

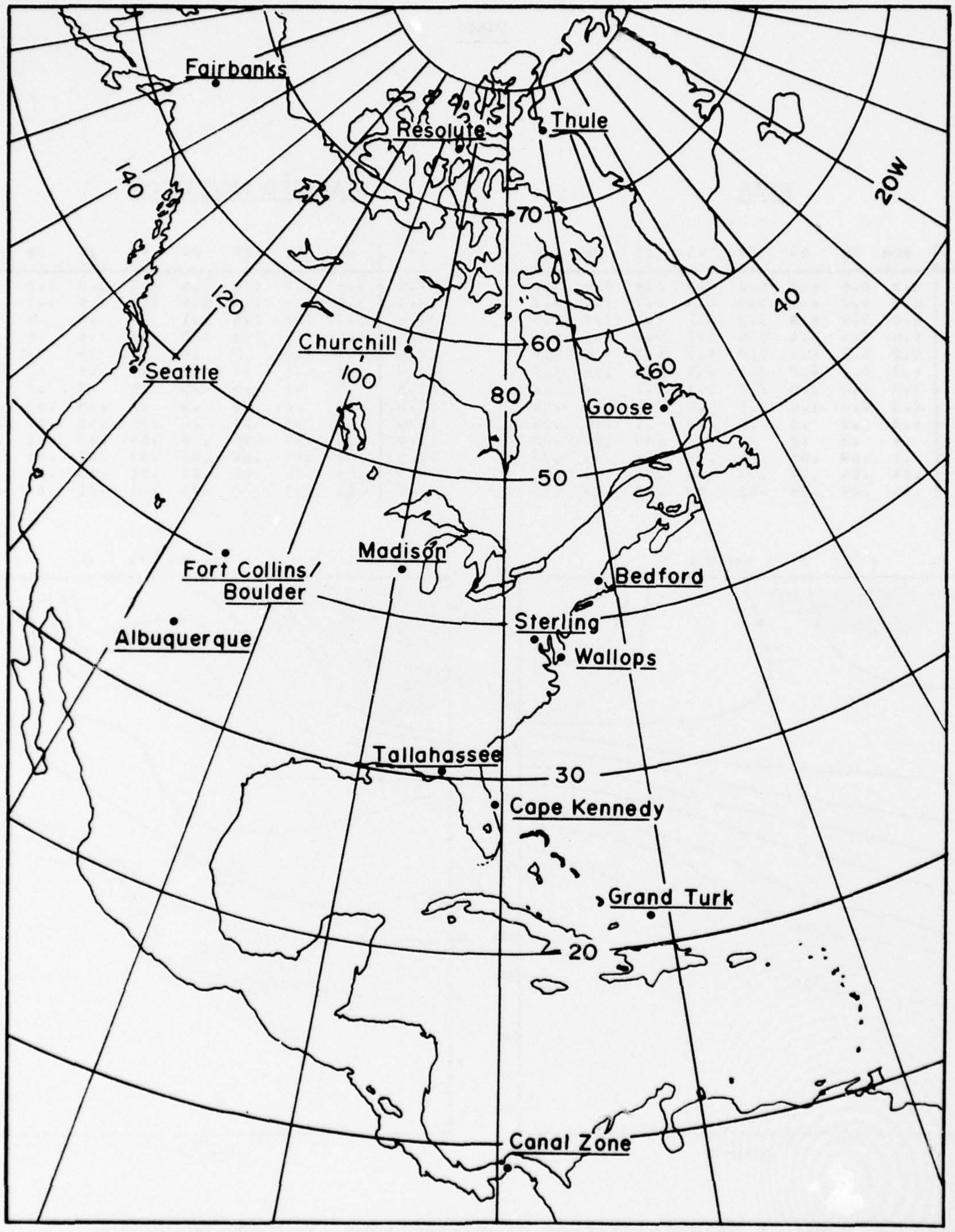


Figure 1. North American ozonesonde stations.

JANUARY

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	6.8	6.6	6.3	5.8	6.3	6.8	8.2	8.6
30.0	6.3	6.2	6.1	5.9	6.3	6.7	7.7	8.2
27.5	6.0	5.9	5.8	5.8	6.2	6.4	7.0	7.5
25.0	5.5	5.5	5.4	5.5	5.7	5.8	5.7	5.5
22.5	5.2	5.2	5.1	5.0	4.8	4.3	3.4	3.0
20.0	4.3	4.2	4.0	3.5	3.0	2.1	1.6	1.1
17.5	3.3	2.8	2.5	2.0	1.4	.7	.4	.2
15.0	2.3	1.8	1.5	1.1	.6	.3	.09	.04
12.5	1.3	.9	.7	.5	.3	.1	.05	.03
10.0	.4	.3	.2	.2	.1	.06	.03	.03
7.5	.1	.09	.08	.06	.05	.04	.03	.03
5.0	.04	.04	.04	.03	.03	.03	.03	.02
2.5	.04	.04	.04	.02	.03	.03	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.8	1.9	1.6	1.5	1.3	1.2	1.2	.5
30.0	1.8	1.8	1.6	1.4	1.1	1.0	1.0	.5
27.5	1.7	1.7	1.5	1.1	.9	.8	.8	.5
25.0	1.6	1.5	1.3	1.0	.8	.6	.5	.4
22.5	1.0	1.0	.9	.8	.7	.6	.5	.3
20.0	.6	.6	.7	.7	.7	.5	.3	.2
17.5	.5	.5	.5	.5	.5	.3	.2	.07
15.0	.4	.4	.4	.3	.2	.05	.03	.02
12.5	.3	.3	.3	.2	.15	.07	.02	.01
10.0	.10	.09	.09	.08	.07	.03	.01	.01
7.5	.06	.05	.04	.03	.02	.02	.01	.01
5.0	.01	.01	.02	.01	.01	.01	.01	.01
2.5	.01	.01	.02	.01	.01	.01	.01	.01

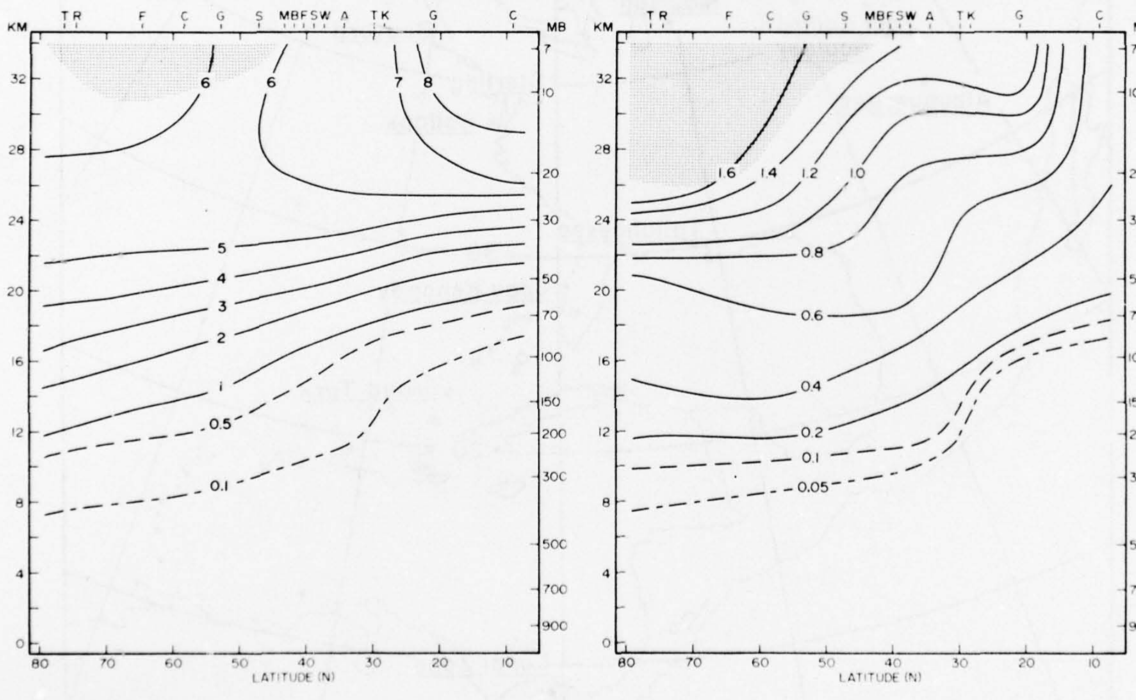


Figure 2. Monthly height-latitude cross-sections of ozone means and standard deviations near 80°W in units parts per million by volume. Shaded areas have no data. The pressure scale is approximate, based on the annual mid-latitude average.

FEBRUARY

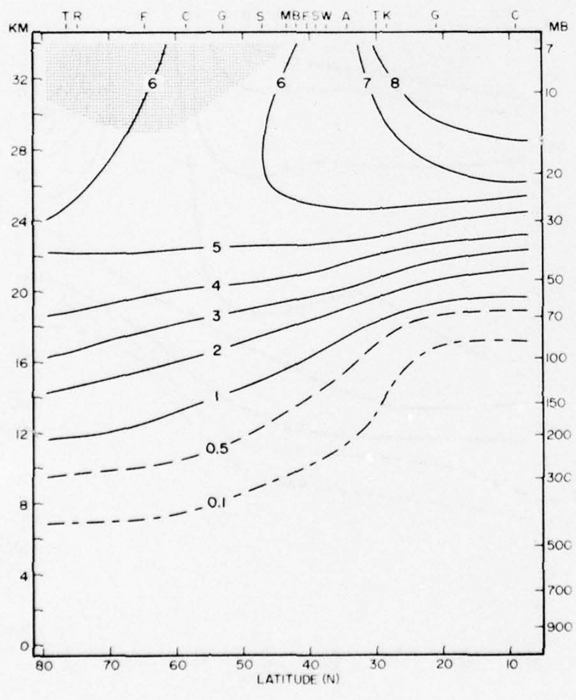
PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	6.4	6.2	5.9	5.8	6.3	7.5	8.3	8.5
30.0	6.3	6.1	5.8	5.9	6.4	6.9	8.1	8.3
27.5	6.2	6.0	5.7	5.9	6.3	6.7	7.2	7.6
25.0	6.1	5.7	5.5	5.8	6.0	6.1	6.0	5.5
22.5	5.0	5.1	5.0	5.0	5.0	4.4	3.8	3.3
20.0	4.4	4.3	4.0	3.7	3.3	2.4	1.5	1.2
17.5	3.5	3.2	2.7	2.2	1.6	.7	.2	.2
15.0	2.3	2.0	1.6	1.2	.7	.2	.07	.06
12.5	1.2	1.2	.8	.6	.4	.09	.05	.04
10.0	.5	.5	.3	.2	.1	.05	.03	.03
7.5	.2	.2	.1	.06	.05	.04	.03	.03
5.0	.04	.03	.03	.03	.04	.03	.03	.03
2.5	.04	.03	.03	.03	.04	.04	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.8	1.6	1.4	1.3	1.2	1.0	1.0	1.2
30.0	1.6	1.4	1.2	1.0	1.1	1.0	.9	1.0
27.5	1.4	1.3	.9	.8	.8	.9	.9	1.0
25.0	1.2	1.1	.8	.8	.8	.8	.8	.8
22.5	.9	.8	.7	.7	.7	.7	.6	.6
20.0	.8	.7	.7	.7	.7	.6	.3	.2
17.5	.7	.7	.7	.6	.6	.4	.07	.07
15.0	.5	.6	.5	.5	.4	.10	.02	.03
12.5	.3	.3	.3	.2	.2	.04	.02	.02
10.0	.10	.10	.10	.10	.08	.03	.01	.01
7.5	.05	.04	.04	.03	.03	.02	.01	.01
5.0	.01	.01	.01	.01	.01	.01	.01	.01
2.5	.01	.01	.01	.01	.01	.01	.01	.01



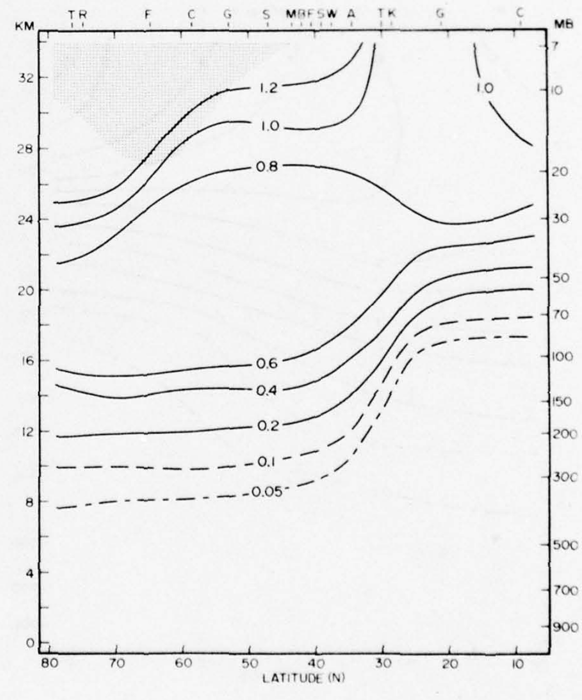


Figure 2 (cont'd).

MARCH

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	6.1	5.9	5.9	6.5	7.3	8.0	8.6	10.0
30.0	5.8	5.7	5.9	6.5	6.9	7.5	8.3	9.1
27.5	5.5	5.6	5.9	6.3	6.4	6.8	7.3	7.9
25.0	5.2	5.4	5.7	6.0	5.8	5.7	5.3	5.2
22.5	4.7	5.1	5.2	5.1	4.5	4.0	3.3	3.0
20.0	4.0	4.1	4.1	3.8	3.2	2.3	1.6	1.0
17.5	3.0	2.9	2.6	2.0	1.4	.6	.3	.2
15.0	1.8	1.7	1.5	1.1	.7	.3	.1	.06
12.5	1.0	.9	.8	.6	.3	.1	.06	.04
10.0	.5	.4	.3	.2	.1	.05	.04	.04
7.5	.1	.1	.07	.06	.06	.04	.04	.04
5.0	.05	.04	.04	.03	.05	.04	.04	.03
2.5	.04	.04	.03	.03	.04	.04	.04	.03

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.3	1.2	1.2	1.2	1.1	.8	.5	1.4
30.0	1.0	1.0	1.0	.9	.9	.8	.5	1.0
27.5	.8	.8	.8	.8	.8	.7	.5	.7
25.0	.7	.7	.7	.7	.7	.6	.5	.6
22.5	.7	.7	.7	.7	.7	.6	.5	.4
20.0	.7	.7	.6	.6	.6	.5	.4	.2
17.5	.6	.6	.6	.5	.5	.3	.15	.04
15.0	.5	.5	.5	.4	.3	.2	.03	.02
12.5	.3	.3	.3	.3	.2	.08	.02	.02
10.0	.15	.10	.08	.08	.07	.02	.01	.01
7.5	.07	.05	.03	.03	.02	.02	.01	.01
5.0	.01	.01	.01	.02	.02	.01	.01	.01
2.5	.01	.01	.01	.01	.02	.01	.01	.01

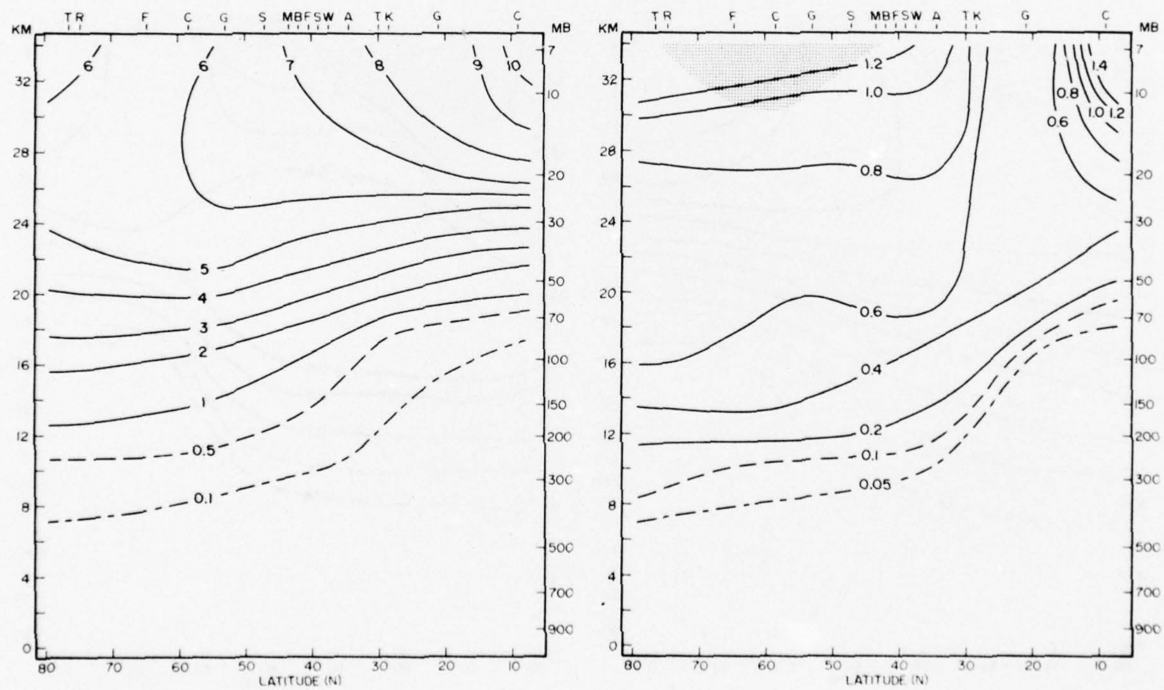


Figure 2 (cont'd).

APRIL

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	6.1	5.8	5.8	6.5	7.3	7.7	8.4	9.0
30.0	5.8	5.6	5.8	6.4	7.1	7.6	8.2	8.4
27.5	5.5	5.5	5.7	6.1	6.6	7.0	7.5	7.6
25.0	5.3	5.3	5.4	5.6	5.8	6.0	6.0	5.7
22.5	5.0	4.8	4.7	4.6	4.3	4.0	3.6	3.3
20.0	4.2	4.1	3.7	3.3	2.7	2.1	1.6	1.1
17.5	3.2	2.8	2.5	2.0	1.3	.6	.4	.2
15.0	2.1	1.8	1.5	1.0	.7	.3	.1	.07
12.5	1.1	1.0	.8	.6	.4	.1	.07	.04
10.0	.5	.4	.3	.2	.1	.06	.05	.04
7.5	.1	.1	.1	.08	.07	.05	.04	.04
5.0	.05	.04	.03	.05	.06	.05	.04	.04
2.5	.04	.03	.03	.05	.05	.05	.04	.04

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.1	1.2	1.2	1.3	1.2	1.0	.6	1.0
30.0	1.1	1.1	1.1	1.1	1.0	.8	.6	.9
27.5	.8	.9	.9	.9	.9	.7	.7	.7
25.0	.6	.7	.7	.7	.6	.5	.6	.7
22.5	.5	.6	.6	.5	.5	.4	.4	.4
20.0	.5	.5	.5	.5	.5	.4	.3	.2
17.5	.5	.5	.5	.5	.4	.3	.10	.07
15.0	.4	.4	.4	.4	.3	.15	.05	.03
12.5	.3	.3	.3	.3	.3	.05	.03	.02
10.0	.15	.15	.15	.15	.10	.03	.02	.02
7.5	.07	.07	.07	.05	.03	.02	.02	.02
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2.5	.01	.01	.01	.02	.02	.01	.02	.02

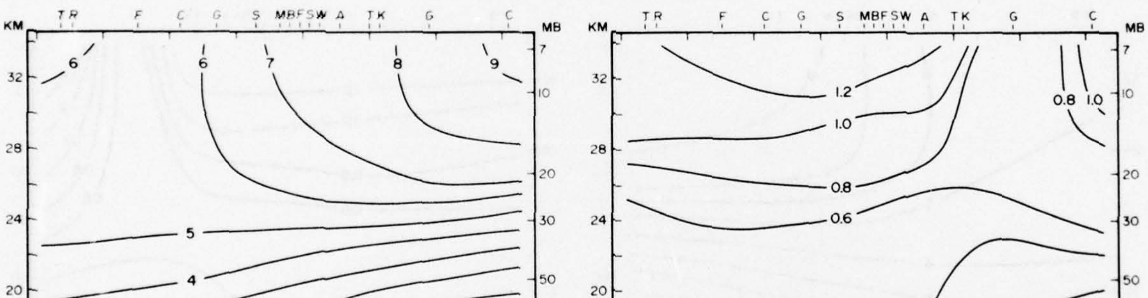


Figure 2 (cont'd).

MAY

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	5.3	5.4	5.7	6.3	7.3	8.2	8.4	8.5
30.0	5.0	5.2	5.6	6.3	7.3	7.9	8.2	8.4
27.5	4.7	4.9	5.3	6.1	7.1	7.3	7.5	7.8
25.0	4.4	4.5	4.7	5.2	5.7	5.8	5.8	5.7
22.5	4.1	4.2	4.2	4.3	4.2	4.0	3.7	3.4
20.0	3.5	3.4	3.3	3.1	2.7	2.2	1.6	1.2
17.5	2.8	2.3	2.0	1.8	1.3	.7	.4	.3
15.0	1.7	1.5	1.3	1.0	.6	.3	.2	.07
12.5	1.0	.8	.8	.6	.3	.2	.08	.05
10.0	.5	.5	.3	.2	.1	.07	.06	.03
7.5	.1	.1	.1	.09	.07	.06	.06	.03
5.0	.05	.05	.04	.05	.06	.05	.05	.03
2.5	.04	.03	.04	.04	.05	.05	.04	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.3	1.3	1.3	1.3	1.3	1.3	.5	1.4
30.0	1.0	1.0	1.0	1.1	1.1	1.1	.5	1.2
27.5	.8	.8	.9	.9	.8	.8	.5	1.0
25.0	.6	.6	.6	.6	.6	.6	.5	.5
22.5	.5	.5	.5	.5	.5	.5	.5	.5
20.0	.5	.5	.5	.5	.4	.3	.3	.3
17.5	.5	.5	.5	.4	.4	.3	.2	.10
15.0	.4	.4	.4	.3	.3	.15	.06	.03
12.5	.3	.3	.3	.3	.2	.07	.04	.02
10.0	.15	.15	.15	.15	.08	.03	.02	.01
7.5	.10	.08	.08	.06	.03	.02	.02	.02
5.0	.02	.02	.02	.02	.02	.01	.02	.02
2.5	.01	.01	.01	.02	.02	.01	.01	.01

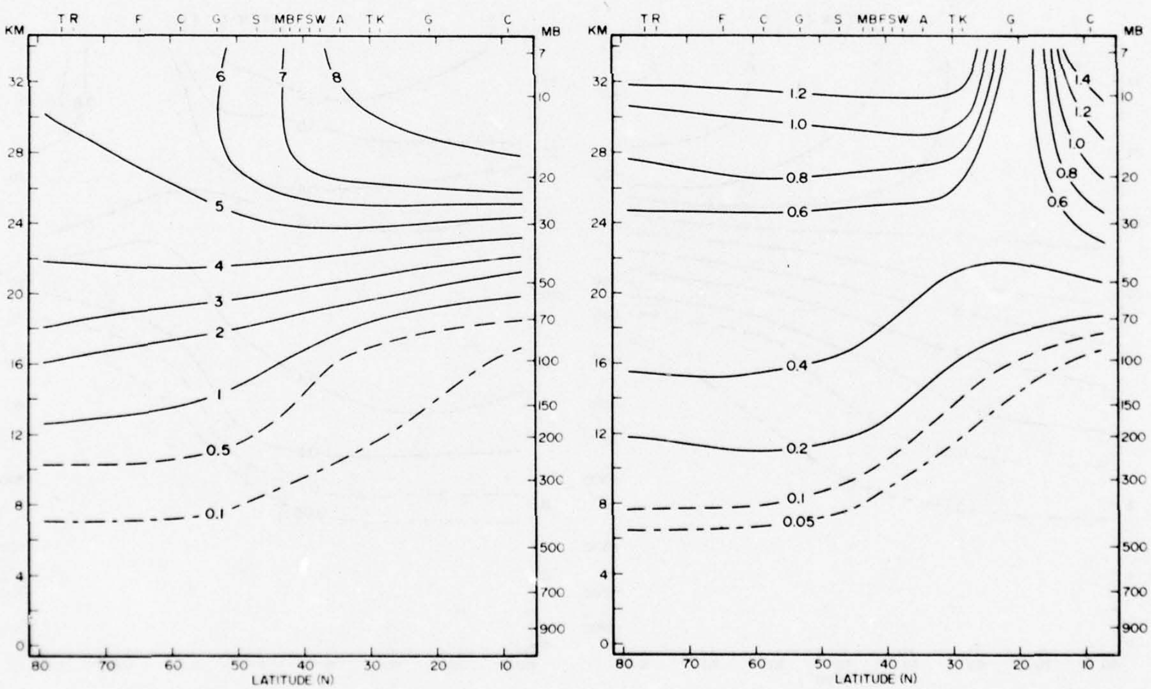


Figure 2 (cont'd).

JUNE

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	5.0	4.8	4.9	6.3	7.3	8.0	7.7	7.5
30.0	4.4	4.4	4.8	6.2	7.0	7.5	7.4	7.3
27.5	3.9	4.2	4.6	5.7	6.5	7.0	7.1	7.1
25.0	3.7	3.9	4.2	4.8	5.4	5.5	5.3	5.1
22.5	3.3	3.4	3.6	3.9	4.0	3.8	3.5	3.2
20.0	3.0	3.0	3.0	2.8	2.4	2.0	1.6	1.2
17.5	2.0	1.9	1.8	1.5	1.0	.7	.5	.3
15.0	1.1	1.1	.9	.7	.4	.3	.2	.1
12.5	.7	.7	.6	.4	.2	.09	.08	.04
10.0	.3	.2	.2	.1	.08	.07	.07	.03
7.5	.1	.1	.07	.06	.07	.06	.06	.03
5.0	.05	.04	.05	.05	.06	.06	.05	.03
2.5	.03	.03	.03	.03	.05	.04	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	.6	.4	.4	.7	1.2	1.3	.7	.6
30.0	.6	.4	.5	.7	1.0	.9	.6	1.0
27.5	.7	.6	.6	.7	.7	.6	.4	.8
25.0	.7	.7	.6	.6	.6	.4	.4	.4
22.5	.6	.6	.5	.5	.5	.3	.3	.3
20.0	.3	.3	.3	.4	.4	.3	.2	.2
17.5	.3	.3	.3	.3	.3	.2	.15	.10
15.0	.2	.2	.3	.3	.2	.15	.10	.03
12.5	.15	.2	.2	.2	.15	.05	.03	.02
10.0	.15	.15	.15	.10	.04	.03	.03	.01
7.5	.05	.05	.04	.03	.03	.02	.03	.01
5.0	.02	.02	.02	.01	.02	.02	.02	.01
2.5	.01	.01	.01	.01	.02	.02	.01	.01

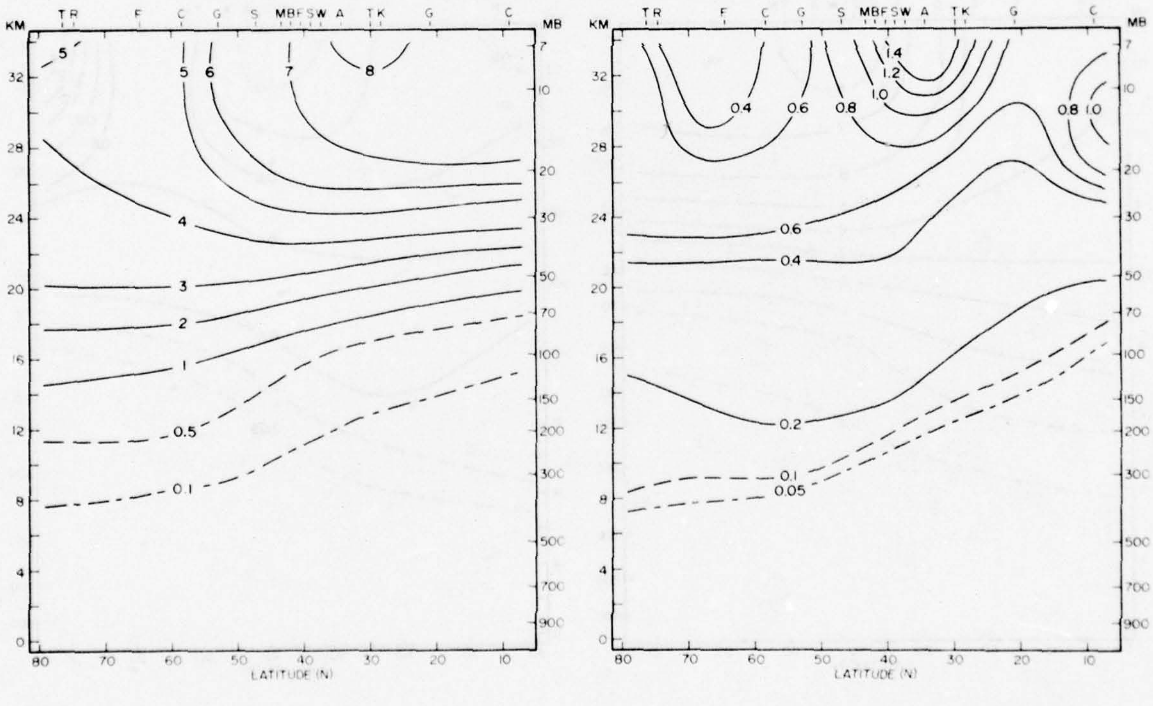


Figure 2 (cont'd).

JULY

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	4.8	4.8	4.9	6.7	8.2	8.0	7.6	7.4
30.0	4.1	4.3	4.8	6.4	7.4	7.5	7.4	7.3
27.5	3.8	4.1	4.7	5.7	6.5	6.7	6.7	6.5
25.0	3.5	3.7	4.0	4.7	5.3	5.5	5.4	5.2
22.5	3.2	3.3	3.4	3.6	3.8	3.6	3.4	3.3
20.0	2.8	2.7	2.6	2.4	2.2	1.8	1.5	1.3
17.5	2.0	1.8	1.7	1.3	.8	.6	.5	.3
15.0	1.2	1.0	.8	.6	.3	.2	.2	.1
12.5	.6	.6	.5	.3	.2	.08	.08	.05
10.0	.3	.2	.1	.1	.08	.08	.06	.04
7.5	.1	.1	.07	.07	.07	.07	.06	.04
5.0	.05	.05	.05	.05	.06	.05	.05	.03
2.5	.04	.04	.03	.04	.05	.04	.04	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	.8	.7	.7	.9	1.1	.7	.5	1.4
30.0	.7	.7	.7	.9	.9	.6	.5	1.0
27.5	.6	.6	.7	.7	.7	.5	.5	.7
25.0	.5	.5	.6	.6	.5	.4	.4	.4
22.5	.4	.4	.5	.4	.4	.3	.3	.3
20.0	.3	.3	.4	.3	.3	.3	.2	.2
17.5	.2	.3	.3	.3	.2	.15	.10	.10
15.0	.15	.2	.2	.2	.15	.07	.04	.03
12.5	.15	.15	.15	.15	.07	.03	.02	.02
10.0	.10	.10	.09	.07	.04	.02	.02	.02
7.5	.07	.05	.04	.03	.03	.02	.02	.01
5.0	.01	.01	.02	.02	.02	.02	.02	.01
2.5	.01	.01	.02	.02	.02	.02	.02	.01

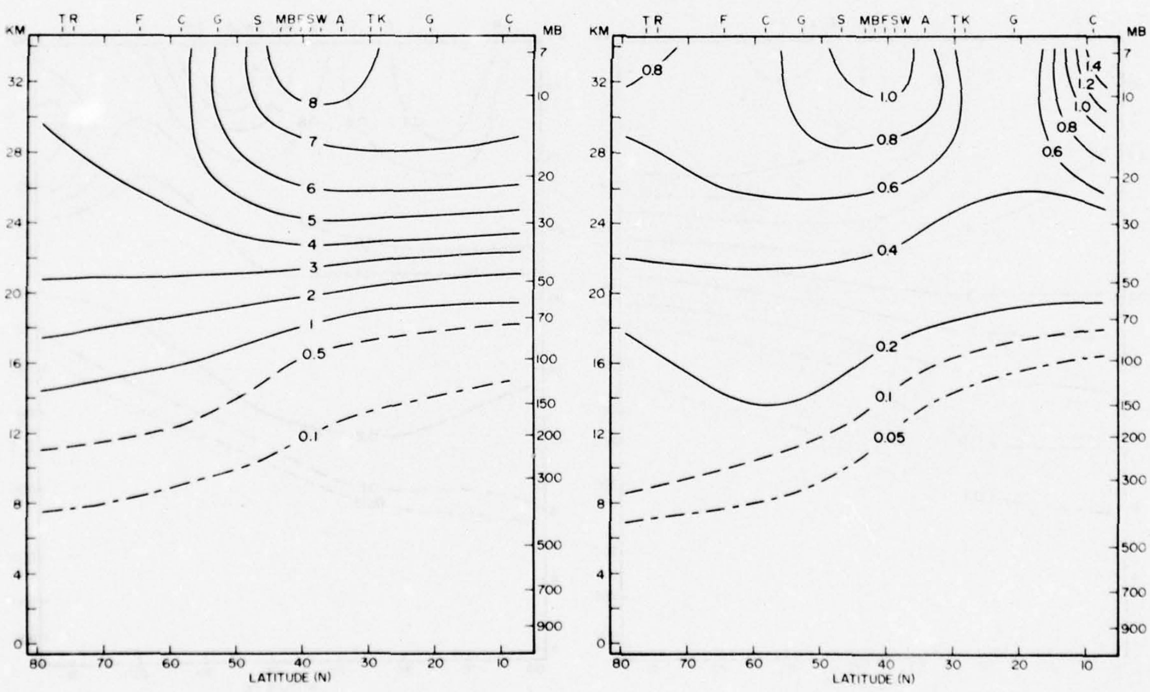


Figure 2 (cont'd).

AUGUST

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	3.9	4.3	4.8	6.4	7.3	7.4	7.6	7.6
30.0	3.7	4.2	4.8	6.3	7.1	7.2	7.4	7.4
27.5	3.6	4.0	4.7	5.8	6.6	7.0	7.1	7.2
25.0	3.4	3.7	4.3	4.8	5.4	5.3	5.3	5.2
22.5	3.3	3.4	3.6	3.7	3.7	3.3	3.2	3.1
20.0	2.8	2.7	2.5	2.3	2.0	1.7	1.3	1.1
17.5	2.0	1.7	1.5	1.1	.7	.5	.3	.2
15.0	1.0	.8	.6	.4	.3	.2	.1	.06
12.5	.5	.4	.3	.3	.1	.08	.07	.04
10.0	.2	.1	.09	.08	.08	.08	.05	.03
7.5	.07	.06	.05	.06	.07	.07	.05	.03
5.0	.05	.05	.04	.05	.06	.06	.05	.03
2.5	.04	.04	.03	.03	.05	.05	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	.4	.5	.6	.7	1.1	.6	.6	.6
30.0	.5	.6	.7	.8	1.1	.6	.5	.5
27.5	.6	.7	.8	.8	.7	.5	.4	.3
25.0	.7	.7	.7	.6	.5	.4	.4	.5
22.5	.5	.5	.5	.4	.3	.3	.4	.4
20.0	.2	.3	.3	.3	.3	.2	.15	.15
17.5	.15	.15	.2	.2	.15	.10	.04	.04
15.0	.10	.15	.15	.15	.15	.07	.04	.02
12.5	.08	.10	.10	.10	.07	.04	.03	.01
10.0	.05	.05	.05	.05	.03	.03	.02	.01
7.5	.03	.03	.03	.03	.03	.03	.02	.01
5.0	.01	.01	.02	.02	.02	.02	.01	.01
2.5	.01	.01	.01	.01	.02	.02	.01	.01

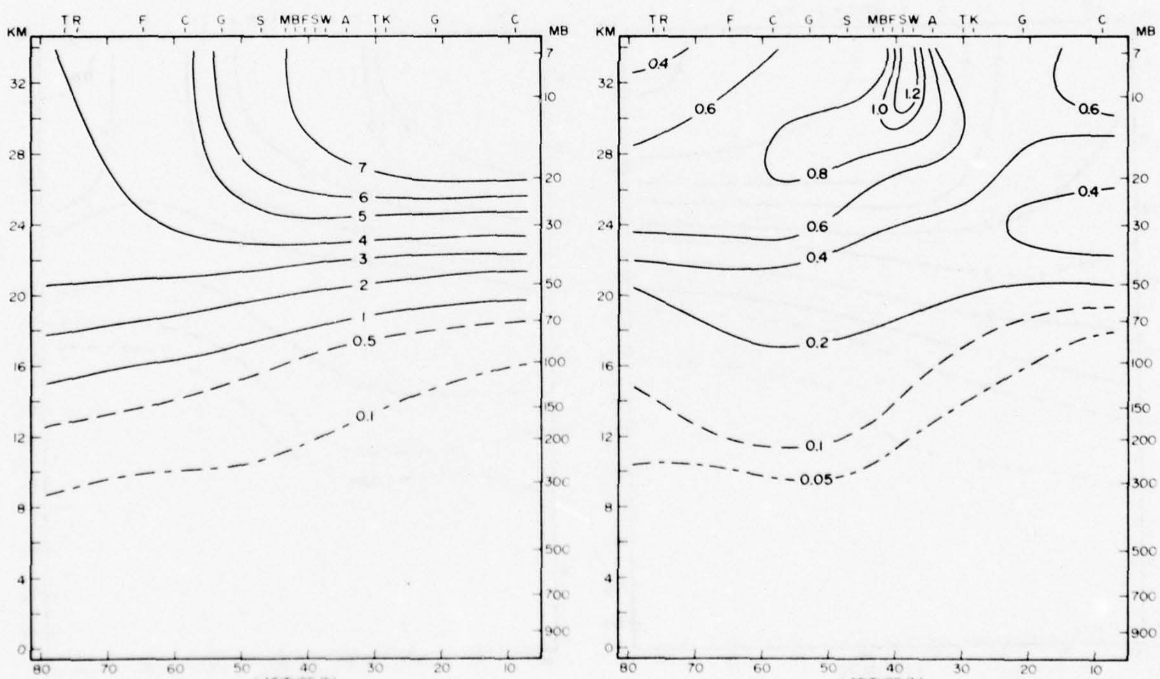


Figure 2 (cont'd).

SEPTEMBER

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	4.3	4.6	5.3	6.4	7.0	7.3	7.6	8.3
30.0	4.1	4.5	5.0	6.3	6.7	7.2	7.4	7.7
27.5	3.8	4.2	4.8	6.2	6.4	6.7	6.8	7.0
25.0	3.5	4.0	4.4	5.2	5.5	5.4	5.2	5.2
22.5	3.2	3.5	3.7	3.7	3.8	3.3	3.0	2.9
20.0	2.7	2.8	2.8	2.5	2.2	1.7	1.3	1.1
17.5	2.1	2.0	1.8	1.3	.8	.5	.3	.3
15.0	1.3	1.0	.7	.4	.3	.1	.09	.08
12.5	.6	.4	.3	.2	.1	.08	.07	.05
10.0	.2	.2	.1	.1	.07	.07	.05	.04
7.5	.1	.07	.05	.05	.05	.05	.05	.04
5.0	.05	.05	.04	.03	.05	.05	.04	.03
2.5	.04	.04	.03	.03	.04	.05	.03	.03

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.2	1.2	1.2	.9	.9	.7	.5	.8
30.0	1.2	1.2	1.2	.9	.8	.6	.5	.7
27.5	1.2	1.2	1.1	.9	.7	.6	.4	.7
25.0	1.1	1.0	.8	.7	.6	.5	.4	.5
22.5	.8	.7	.6	.5	.4	.3	.3	.3
20.0	.4	.4	.3	.3	.3	.2	.15	.2
17.5	.3	.3	.3	.3	.2	.10	.07	.07
15.0	.2	.2	.2	.2	.10	.05	.04	.03
12.5	.15	.15	.15	.15	.07	.03	.03	.01
10.0	.07	.06	.07	.07	.03	.02	.02	.01
7.5	.03	.02	.02	.03	.02	.01	.01	.01
5.0	.01	.01	.01	.01	.02	.01	.01	.01
2.5	.01	.01	.01	.01	.01	.02	.01	.01

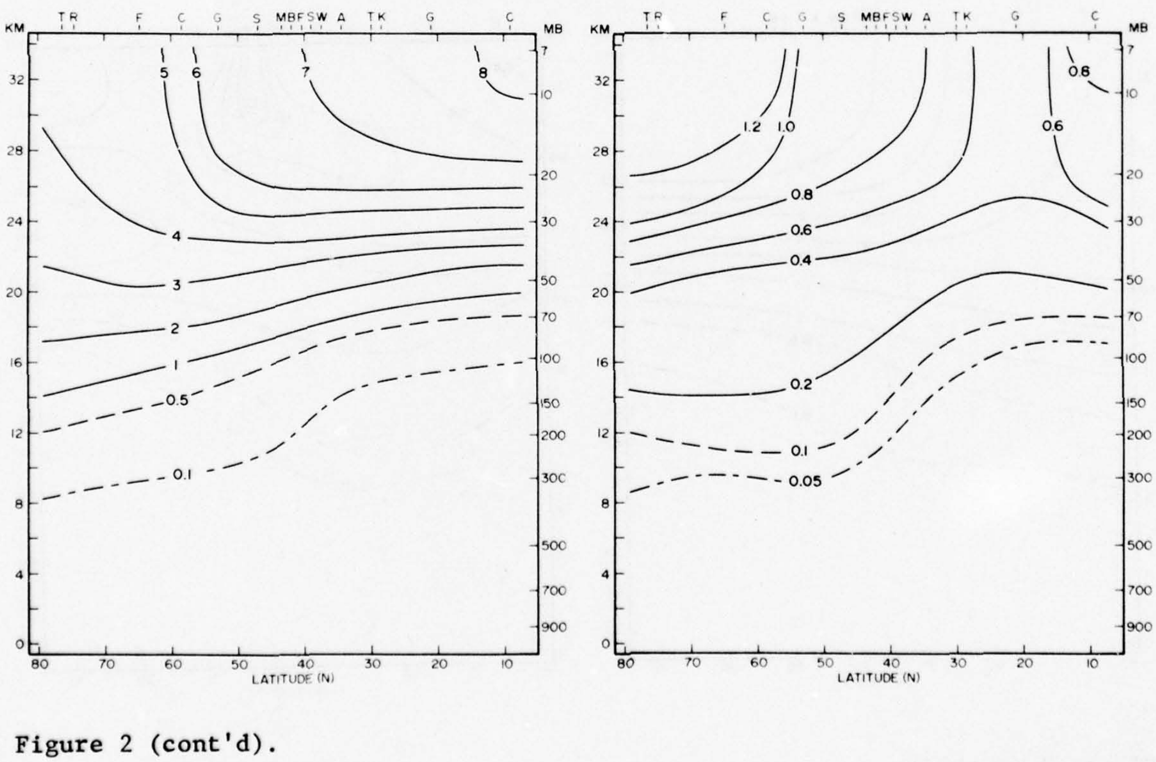


Figure 2 (cont'd).

OCTOBER

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	4.6	4.8	5.2	6.2	7.0	7.8	7.8	7.6
30.0	4.5	4.7	5.0	5.9	6.7	7.3	7.6	7.3
27.5	4.3	4.5	4.8	5.5	6.2	6.6	7.0	7.0
25.0	4.2	4.3	4.4	4.7	5.1	5.4	5.3	5.1
22.5	3.9	3.9	3.8	3.7	3.7	3.5	3.3	3.1
20.0	3.1	2.8	2.5	2.3	2.0	1.7	1.3	1.0
17.5	2.3	2.0	1.6	1.3	.8	.5	.3	.2
15.0	1.3	1.1	.8	.6	.3	.2	.08	.07
12.5	.5	.5	.4	.2	.2	.07	.04	.04
10.0	.2	.2	.1	.08	.06	.06	.04	.03
7.5	.07	.07	.06	.05	.05	.04	.04	.03
5.0	.05	.05	.04	.03	.04	.04	.03	.03
2.5	.03	.03	.03	.03	.04	.04	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.4	1.4	1.3	1.3	1.2	.6	.6	1.0
30.0	1.3	1.3	1.2	1.2	1.0	.5	.6	.9
27.5	1.1	1.1	1.1	.9	.8	.5	.6	.8
25.0	.9	.9	.8	.7	.5	.4	.6	.7
22.5	.7	.6	.4	.4	.4	.3	.3	.4
20.0	.4	.4	.3	.3	.3	.2	.2	.15
17.5	.3	.3	.3	.3	.2	.10	.08	.07
15.0	.2	.2	.2	.2	.15	.07	.03	.02
12.5	.15	.15	.15	.15	.07	.03	.02	.02
10.0	.08	.08	.08	.07	.04	.02	.01	.02
7.5	.04	.03	.03	.03	.03	.01	.01	.01
5.0	.01	.01	.02	.01	.02	.01	.01	.01
2.5	.01	.01	.01	.01	.02	.01	.01	.01

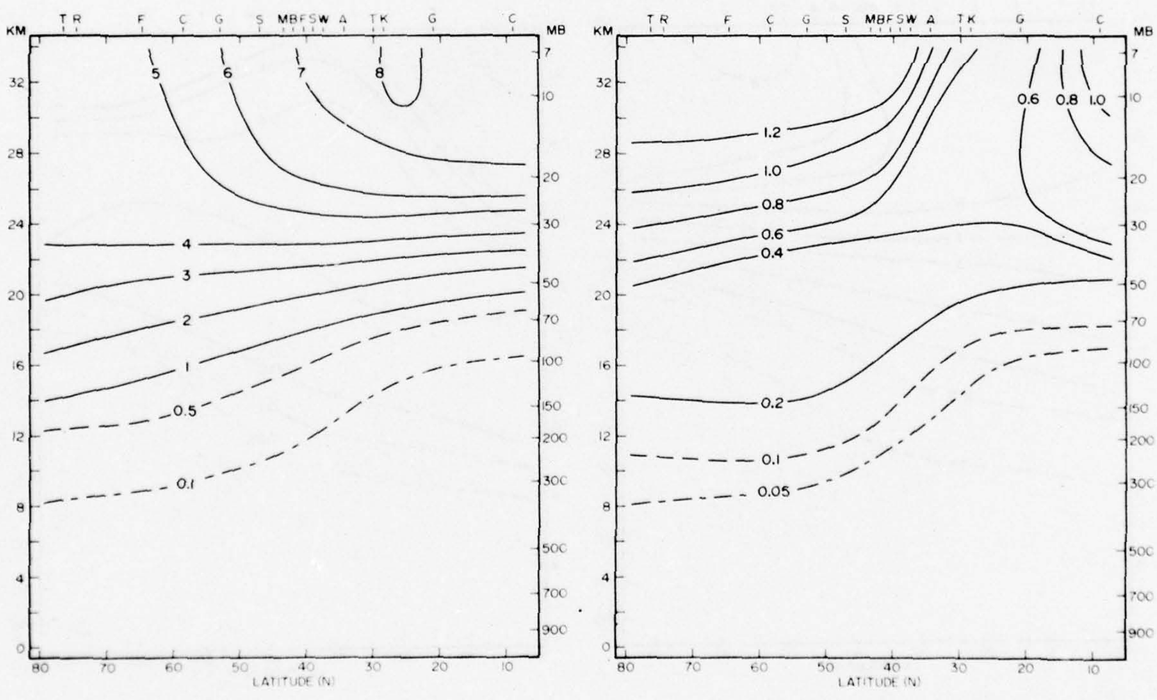


Figure 2 (cont'd).

NOVEMBER

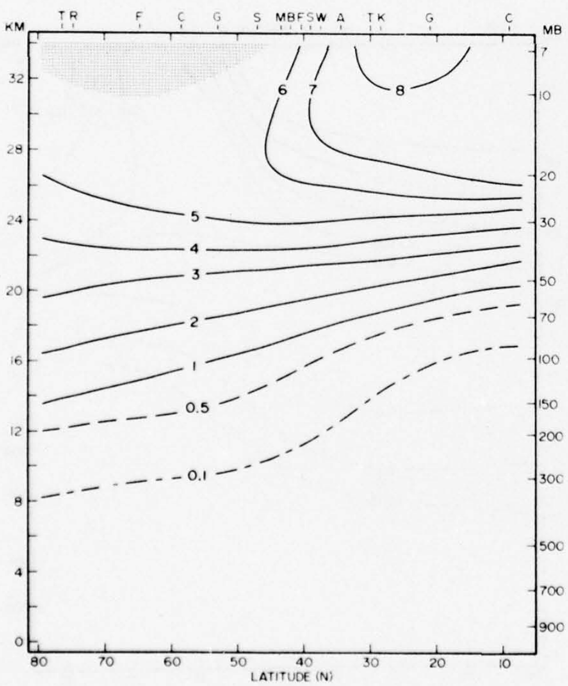
PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	5.5	5.5	5.6	5.7	6.4	8.1	8.0	7.7
30.0	5.3	5.3	5.4	5.8	6.7	7.5	7.6	7.4
27.5	5.2	5.3	5.4	5.8	6.4	7.0	7.1	7.2
25.0	4.7	4.9	5.1	5.3	5.4	5.5	5.6	5.3
22.5	3.8	4.0	4.0	4.0	4.0	3.6	3.3	2.9
20.0	3.2	2.9	2.7	2.5	2.3	1.8	1.3	.9
17.5	2.3	2.0	1.7	1.4	1.0	.5	.3	.2
15.0	1.5	1.1	.9	.7	.4	.2	.07	.05
12.5	.6	.5	.4	.3	.2	.08	.04	.03
10.0	.2	.2	.2	.1	.08	.05	.03	.03
7.5	.08	.07	.07	.05	.06	.04	.03	.03
5.0	.05	.05	.04	.03	.05	.04	.03	.02
2.5	.04	.04	.03	.03	.04	.04	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.4	1.4	1.2	.8	.8	1.0	1.1	1.1
30.0	1.3	1.3	.9	.6	.6	.7	.8	.8
27.5	1.3	1.2	.7	.5	.5	.5	.5	.5
25.0	1.2	.9	.5	.5	.5	.4	.4	.5
22.5	.7	.6	.5	.5	.4	.3	.3	.4
20.0	.5	.5	.5	.4	.3	.3	.2	.2
17.5	.4	.4	.4	.3	.3	.2	.10	.05
15.0	.3	.3	.3	.2	.2	.10	.02	.02
12.5	.3	.2	.15	.15	.08	.03	.01	.01
10.0	.15	.08	.07	.06	.04	.02	.01	.01
7.5	.05	.04	.03	.03	.03	.01	.01	.01
5.0	.02	.02	.02	.01	.02	.01	.01	.01
2.5	.01	.01	.01	.01	.02	.01	.01	.01



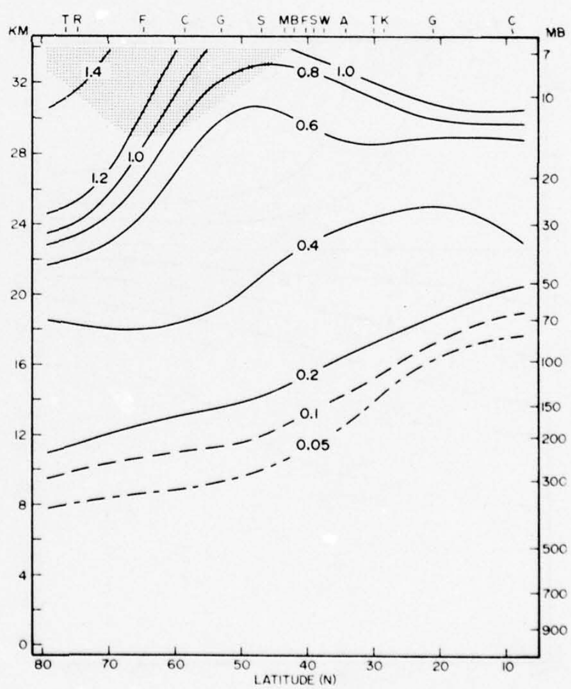


Figure 2 (cont'd).

DECEMBER

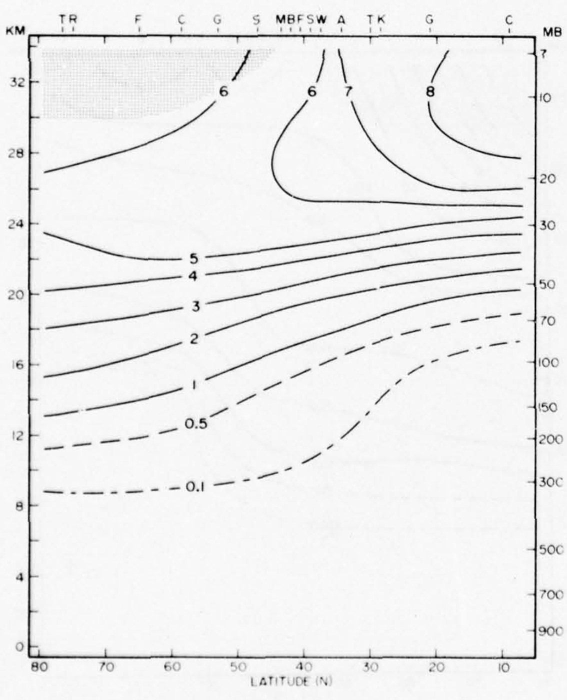
PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	6.4	6.4	6.3	6.0	5.9	7.3	8.0	8.3
30.0	6.2	6.2	6.1	5.8	6.2	7.2	8.1	8.4
27.5	6.1	5.9	5.7	5.7	6.3	6.7	7.4	7.8
25.0	5.4	5.4	5.4	5.6	5.8	5.8	6.0	5.9
22.5	4.7	5.0	5.2	5.0	4.6	4.0	3.4	3.1
20.0	3.9	3.7	3.5	3.1	2.5	1.8	1.3	.9
17.5	2.8	2.6	2.2	1.6	1.0	.6	.3	.1
15.0	2.0	1.5	1.2	.7	.4	.2	.07	.05
12.5	.8	.7	.5	.3	.3	.09	.05	.04
10.0	.3	.3	.2	.1	.09	.05	.03	.03
7.5	.07	.07	.06	.05	.06	.04	.03	.03
5.0	.04	.04	.03	.03	.05	.04	.03	.02
2.5	.03	.03	.03	.03	.04	.03	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.2	1.2	1.0	1.0	.9	1.0	1.1	1.1
30.0	1.1	1.1	1.0	.9	.8	.8	.8	.8
27.5	1.1	1.1	1.0	.8	.7	.6	.5	.5
25.0	1.1	1.1	1.0	.7	.6	.5	.4	.4
22.5	1.0	1.0	.8	.6	.5	.4	.3	.3
20.0	.6	.6	.6	.5	.4	.3	.3	.2
17.5	.5	.5	.5	.4	.3	.2	.10	.06
15.0	.3	.4	.4	.3	.2	.10	.03	.02
12.5	.2	.2	.2	.15	.15	.05	.02	.01
10.0	.10	.08	.08	.07	.05	.03	.01	.01
7.5	.03	.03	.03	.03	.03	.02	.01	.01
5.0	.01	.01	.02	.01	.02	.01	.01	.01
2.5	.01	.01	.02	.01	.01	.01	.01	.01



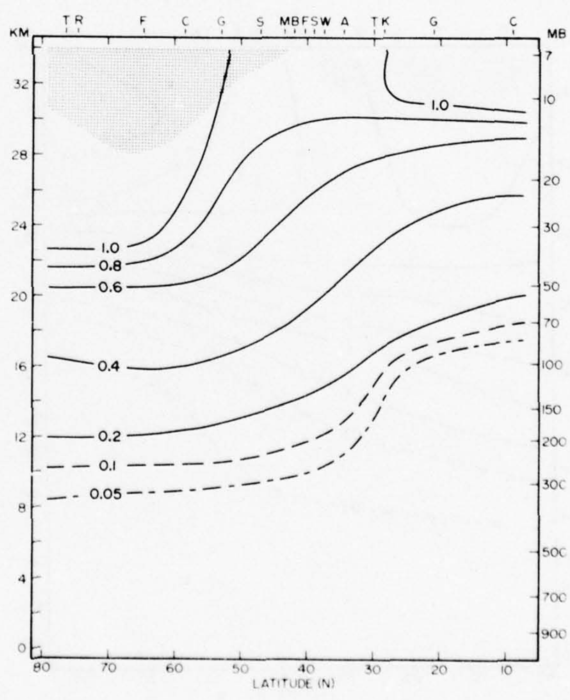


Figure 2 (cont'd).

DECEMBER - FEBRUARY

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	6.3	6.5	6.3	5.8	6.2	7.3	8.0	8.3
30.0	6.0	6.3	6.2	5.7	6.2	7.0	8.0	8.3
27.5	5.7	6.2	6.1	5.7	6.2	6.7	7.0	7.6
25.0	5.5	6.0	5.9	5.5	5.8	5.8	5.7	5.7
22.5	5.0	5.2	5.2	5.0	4.9	4.3	3.5	3.1
20.0	4.3	4.1	3.8	3.5	3.0	2.1	1.3	.9
17.5	3.4	3.1	2.4	1.8	1.3	.6	.3	.2
15.0	2.4	1.9	1.4	1.0	.5	.2	.08	.06
12.5	1.2	.9	.6	.4	.3	.1	.04	.03
10.0	.5	.4	.2	.2	.1	.06	.03	.03
7.5	.1	.1	.08	.07	.06	.04	.03	.03
5.0	.04	.04	.04	.03	.04	.03	.03	.02
2.5	.04	.04	.03	.03	.04	.03	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	2.3	2.0	1.4	1.1	1.2	1.0	1.2	1.0
30.0	2.2	1.8	1.3	1.1	1.0	.9	.9	.9
27.5	1.9	1.5	1.2	.9	.8	.8	.7	.7
25.0	1.4	1.2	1.1	.8	.7	.6	.6	.6
22.5	1.1	1.0	.9	.7	.7	.5	.5	.5
20.0	.8	.8	.7	.7	.6	.5	.4	.3
17.5	.7	.6	.6	.6	.5	.3	.15	.08
15.0	.6	.5	.5	.4	.4	.10	.03	.02
12.5	.4	.4	.3	.3	.2	.07	.02	.01
10.0	.15	.15	.15	.10	.09	.03	.01	.01
7.5	.05	.05	.05	.04	.03	.02	.01	.01
5.0	.01	.01	.02	.01	.02	.01	.01	.01
2.5	.01	.01	.02	.01	.01	.01	.01	.01

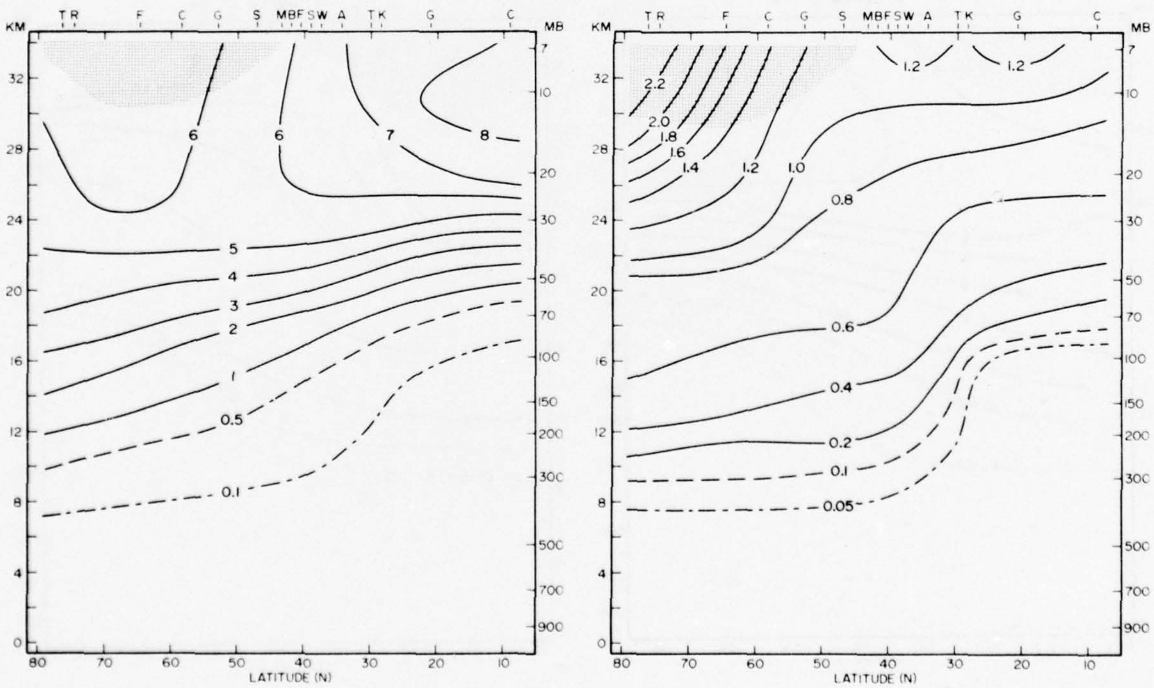


Figure 3. Seasonal height-latitude cross-sections of ozone means and standard deviations near 80°W in units parts per million by volume. Shaded areas have no data. The pressure scale is approximate, based on the annual mid-latitude average.

MARCH - MAY

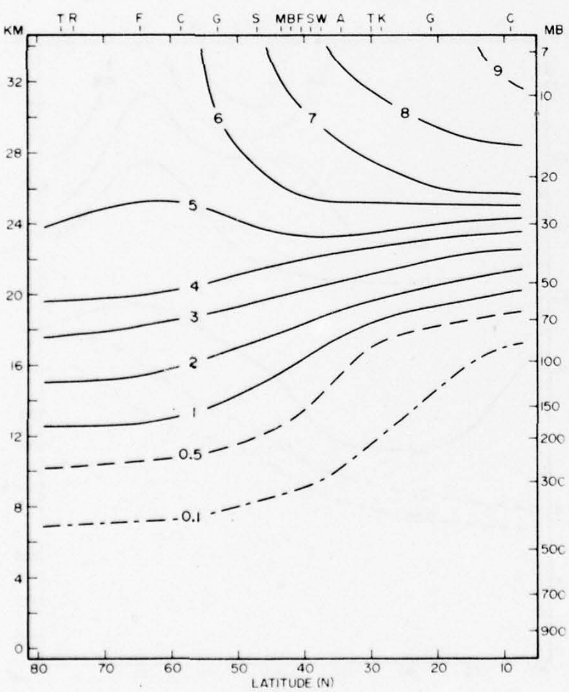
PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	5.5	5.6	5.8	6.4	7.3	8.2	8.5	9.0
30.0	5.4	5.5	5.7	6.2	6.9	7.6	8.2	8.4
27.5	5.3	5.3	5.3	5.8	6.4	6.9	7.4	7.7
25.0	5.2	5.0	4.9	5.2	5.8	5.9	5.9	5.9
22.5	4.7	4.5	4.4	4.4	4.3	4.0	3.5	3.0
20.0	4.1	4.0	3.8	3.3	2.9	2.2	1.7	1.0
17.5	3.0	2.8	2.6	2.2	1.4	.6	.3	.2
15.0	2.0	1.9	1.7	1.2	.7	.3	.1	.07
12.5	1.0	1.0	.8	.6	.4	.1	.08	.05
10.0	.5	.4	.3	.2	.1	.06	.06	.04
7.5	.1	.1	.1	.08	.07	.05	.05	.04
5.0	.05	.05	.04	.05	.05	.05	.05	.03
2.5	.04	.04	.03	.04	.05	.05	.04	.03

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.3	1.2	1.2	1.2	1.3	1.2	.6	1.6
30.0	1.1	1.0	.9	1.0	1.1	1.0	.6	1.2
27.5	.9	.9	.9	.8	.9	.8	.6	.9
25.0	.8	.8	.8	.7	.6	.5	.5	.7
22.5	.7	.7	.7	.6	.5	.5	.5	.5
20.0	.6	.6	.6	.6	.5	.5	.3	.3
17.5	.5	.5	.6	.5	.5	.3	.15	.08
15.0	.4	.4	.5	.4	.3	.2	.05	.02
12.5	.3	.3	.3	.3	.3	.08	.03	.02
10.0	.15	.2	.2	.15	.10	.03	.02	.02
7.5	.10	.08	.07	.06	.04	.02	.02	.02
5.0	.02	.01	.01	.02	.02	.02	.02	.02
2.5	.01	.01	.01	.02	.02	.02	.01	.02



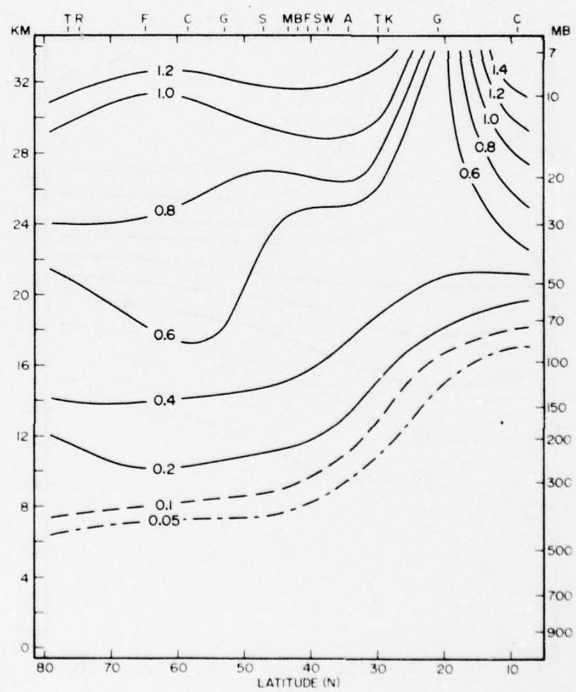


Figure 3 (cont'd).

JUNE - AUGUST

PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	4.3	4.5	4.8	6.4	7.3	7.7	7.3	7.0
30.0	4.0	4.3	4.8	6.2	7.2	7.5	7.3	7.3
27.5	3.8	4.1	4.7	5.7	6.5	6.9	7.0	7.0
25.0	3.5	3.7	4.0	5.0	5.5	5.5	5.3	5.3
22.5	3.3	3.4	3.5	3.7	3.7	3.5	3.2	3.1
20.0	2.8	2.8	2.8	2.5	2.2	1.8	1.3	.9
17.5	1.8	1.8	1.8	1.4	.9	.7	.4	.3
15.0	.9	1.0	1.0	.7	.4	.2	.2	.08
12.5	.6	.6	.5	.3	.2	.1	.07	.04
10.0	.2	.2	.1	.1	.09	.07	.06	.03
7.5	.1	.08	.07	.07	.07	.06	.05	.03
5.0	.05	.04	.04	.05	.06	.05	.05	.03
2.5	.04	.04	.03	.03	.05	.04	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	.7	.7	.7	.8	1.0	.9	.6	.9
30.0	.7	.7	.7	.7	.8	.8	.5	.9
27.5	.7	.7	.7	.7	.6	.5	.4	.7
25.0	.6	.7	.7	.6	.5	.4	.4	.5
22.5	.4	.5	.5	.5	.4	.4	.4	.4
20.0	.3	.3	.4	.4	.3	.3	.2	.3
17.5	.2	.3	.3	.3	.2	.2	.15	.09
15.0	.2	.2	.3	.3	.2	.15	.06	.03
12.5	.15	.2	.2	.2	.10	.06	.04	.02
10.0	.15	.15	.15	.10	.04	.03	.03	.01
7.5	.08	.06	.04	.03	.03	.02	.02	.01
5.0	.02	.02	.02	.02	.02	.02	.02	.01
2.5	.01	.01	.02	.02	.02	.02	.02	.01

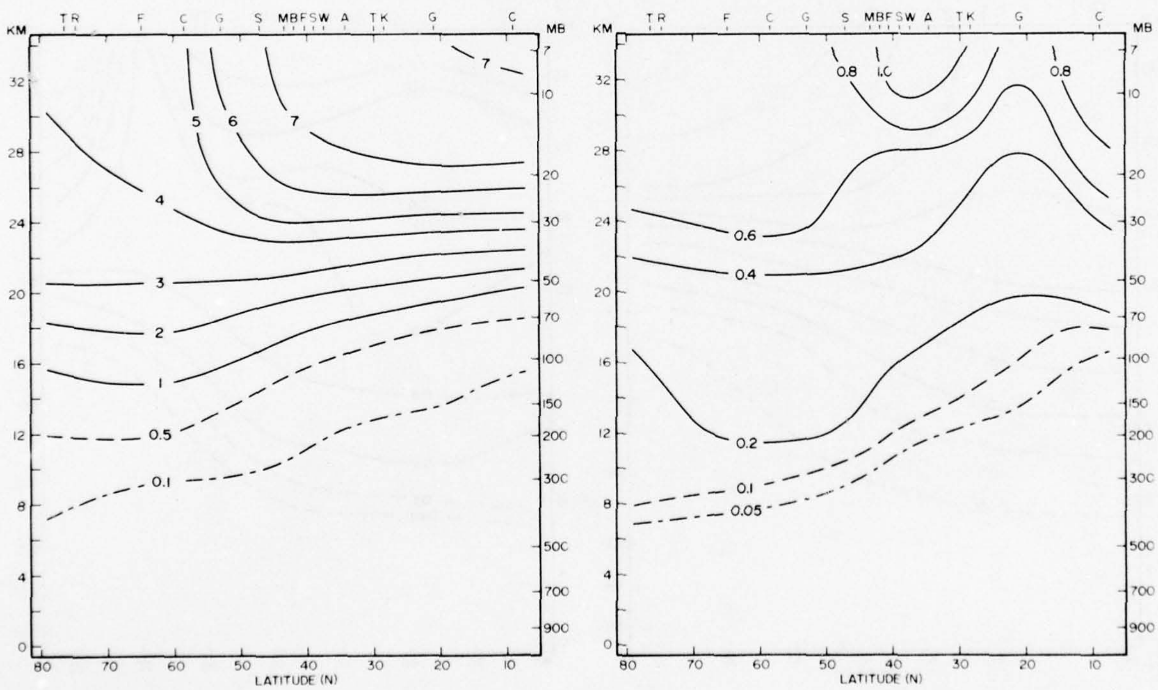


Figure 3 (cont'd).

SEPTEMBER - NOVEMBER

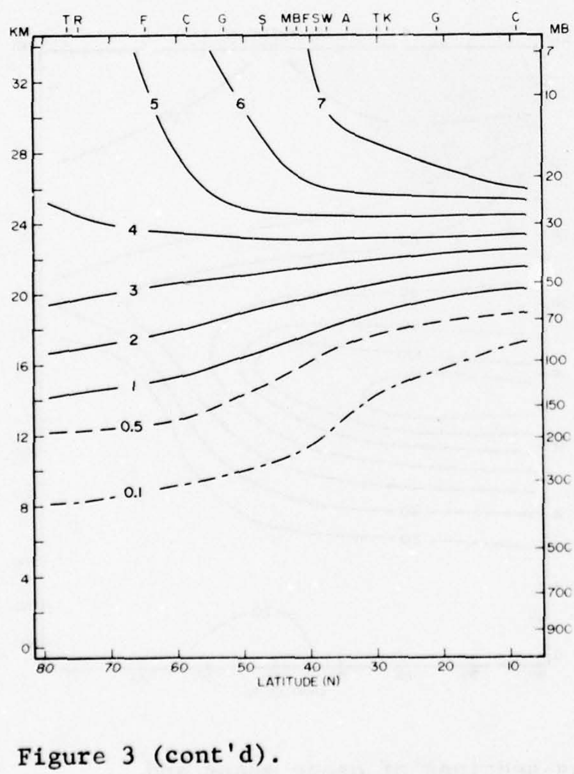
PPMV

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	4.5	4.8	5.4	6.2	6.9	7.2	7.5	7.7
30.0	4.3	4.7	5.2	5.9	6.8	7.2	7.5	7.7
27.5	4.2	4.5	5.0	5.7	6.3	6.7	7.1	7.3
25.0	4.0	4.2	4.5	5.0	5.3	5.5	5.5	5.5
22.5	3.5	3.6	3.7	3.7	3.7	3.5	3.3	3.0
20.0	3.1	3.0	2.7	2.5	2.1	1.7	1.2	1.0
17.5	2.3	2.1	1.8	1.3	1.0	.5	.3	.2
15.0	1.3	1.2	.9	.7	.4	.2	.08	.06
12.5	.6	.5	.4	.3	.2	.07	.05	.04
10.0	.2	.2	.1	.1	.07	.05	.04	.03
7.5	.08	.07	.06	.05	.04	.04	.04	.03
5.0	.05	.04	.04	.03	.04	.04	.04	.03
2.5	.04	.04	.03	.03	.04	.04	.03	.02

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	1.5	1.4	1.3	1.2	1.1	.9	[illegible]	1.2
30.0	1.5	1.4	1.1	1.0	.9	.7	.8	.9
27.5	1.4	1.2	.9	.8	.7	.6	.6	.8
25.0	1.3	1.0	.8	.7	.6	.5	.5	.7
22.5	1.0	.7	.5	.5	.4	.4	.3	.4
20.0	.6	.4	.4	.4	.3	.3	.2	.2
17.5	.4	.3	.3	.3	.3	.15	.09	.07
15.0	.3	.3	.3	.3	.2	.06	.04	.03
12.5	.2	.2	.2	.15	.10	.04	.02	.01
10.0	.08	.08	.08	.07	.04	.03	.02	.01
7.5	.04	.04	.04	.03	.03	.02	.01	.01
5.0	.01	.01	.02	.01	.02	.02	.01	.01
2.5	.01	.01	.01	.01	.02	.02	.01	.01



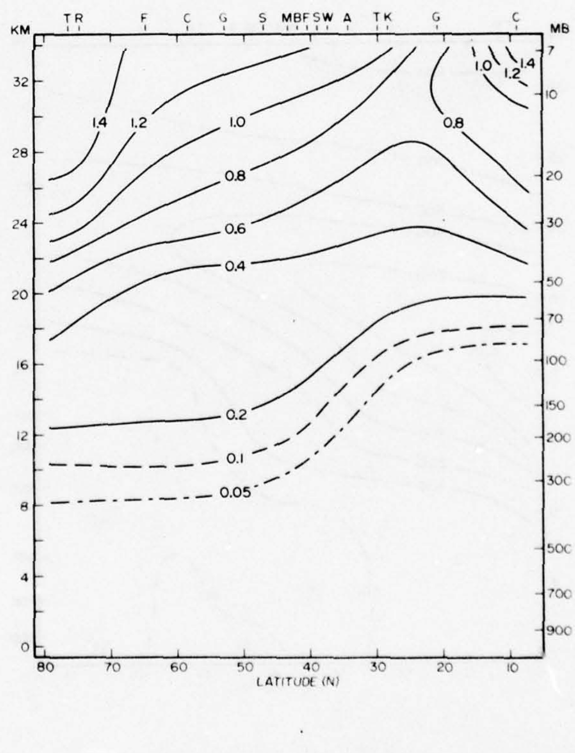


Figure 3 (cont'd).

JANUARY

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	110	110	110	130	130	140	160	170
30.0	140	160	170	180	180	200	230	250
27.5	180	200	220	260	280	300	310	310
25.0	250	290	310	370	400	390•	370	350
22.5	400	440	460	480	460	420	340	300
20.0	500	530	540	510	400	280	220	160
17.5	610	570	500	400	270	170	80	60
15.0	650	510	420	300	170	70	30	20
12.5	530	350	300	200	120	50	25	15
10.0	300	200	140	100	70	40	25	20
7.5	120	60	65	50	45	35	20	20
5.0	60	55	55	35	45	50	30	25
2.5	60	60	60	40	40	50	35	30

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	15	15	15	20	25	20	15	10
30.0	30	25	20	25	30	25	20	15
27.5	60	45	35	35	35	30	30	20
25.0	65	60	50	40	40	35	35	25
22.5	75	70	65	60	60	50	40	35
20.0	90	90	85	85	85	70	60	40
17.5	110	110	115	120	120	80	40	20
15.0	140	145	145	130	110	70	15	5
12.5	120	120	120	100	80	45	10	5
10.0	70	70	70	60	45	20	10	5
7.5	35	30	30	30	20	15	10	5
5.0	15	15	15	15	15	15	10	10
2.5	10	10	15	15	20	15	10	10

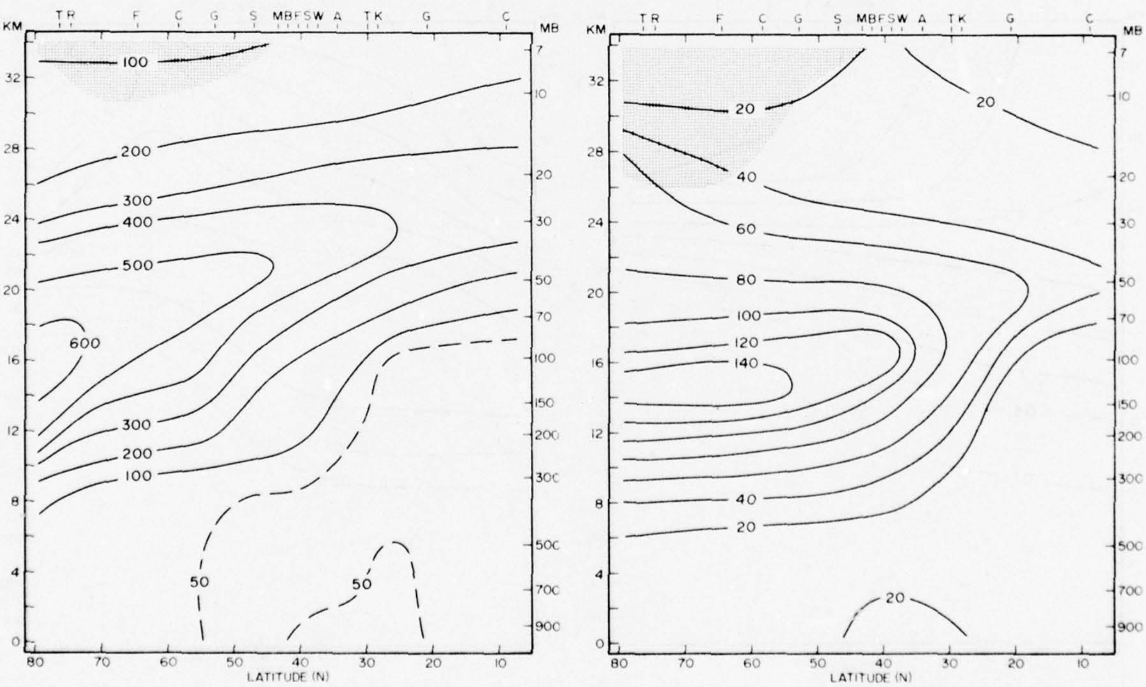


Figure 4. Monthly height-latitude cross-sections of ozone means and standard deviations near 80°W in units micrograms per cubic meter. Shaded areas have no data. The pressure scale is approximate, based on the annual mid-latitude average.

FEBRUARY

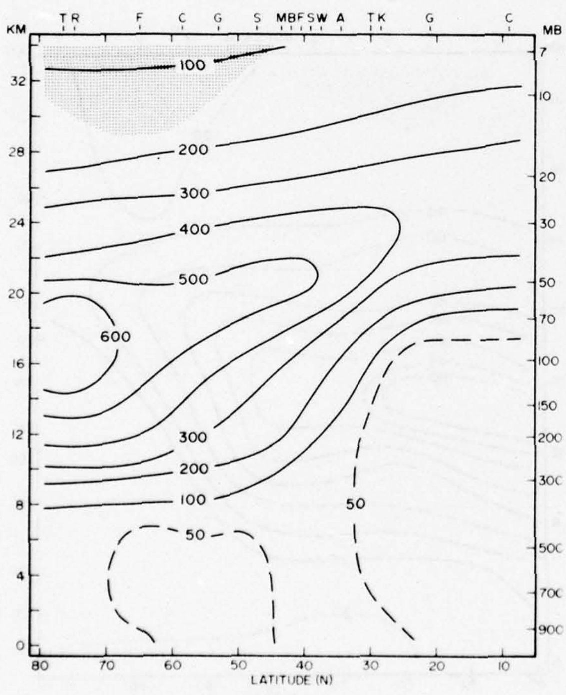
$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	100	100	110	120	130	150	170	170
30.0	120	130	150	170	180	210	240	250
27.5	180	200	220	240	270	300	320	330
25.0	290	310	320	360	380	400	370	360
22.5	380	400	420	460	480	430	330	320
20.0	550	550	510	540	500	320	220	190
17.5	640	610	520	450	340	170	50	50
15.0	610	570	450	350	230	70	25	25
12.5	470	460	370	270	170	50	25	20
10.0	300	300	220	170	80	40	25	20
7.5	100	90	80	70	60	40	30	20
5.0	55	50	35	35	50	35	35	30
2.5	55	50	45	45	55	50	35	35

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	30	20	15	15	20	15	15	30
30.0	50	30	20	25	30	25	15	30
27.5	60	40	30	30	35	35	20	40
25.0	65	40	35	35	40	40	45	50
22.5	70	60	40	45	55	60	60	55
20.0	80	70	50	60	85	80	50	40
17.5	95	85	80	100	140	90	30	15
15.0	140	100	100	135	140	65	10	10
12.5	140	120	100	105	110	30	10	10
10.0	85	75	80	90	80	20	10	5
7.5	45	40	50	50	35	15	10	10
5.0	15	10	15	15	15	15	10	10
2.5	15	10	15	20	20	15	15	15



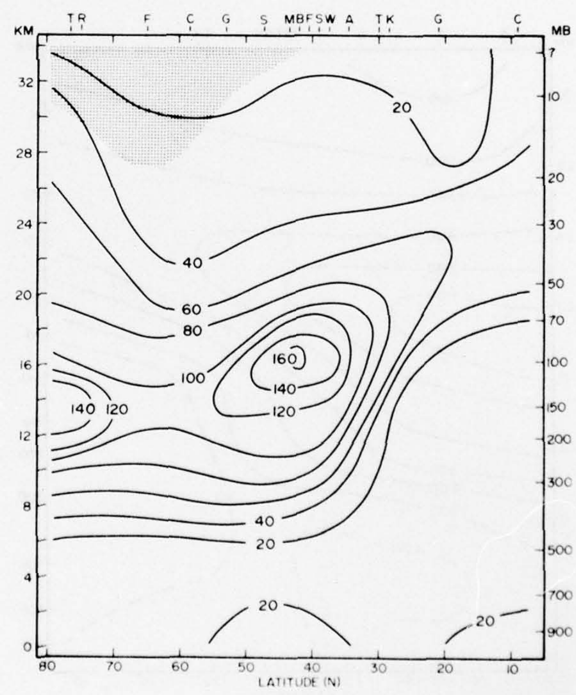


Figure 4 (cont'd).

MARCH

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	150	100	100	130	150	160	170	190
30.0	210	160	160	170	190	210	240	270
27.5	270	250	250	260	270	290	320	340
25.0	380	370	360	360	370	370	360	360
22.5	480	480	480	480	460	420	340	290
20.0	600	610	610	550	450	340	220	140
17.5	630	620	560	450	330	170	80	50
15.0	560	500	470	350	220	80	40	20
12.5	440	410	370	270	180	60	30	20
10.0	300	250	210	150	100	40	30	25
7.5	150	100	70	50	55	40	30	25
5.0	60	55	45	45	50	50	45	30
2.5	60	50	50	45	60	60	60	45

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	30	25	25	25	25	15	10	25
30.0	30	30	25	25	25	20	15	30
27.5	35	35	35	35	35	25	15	30
25.0	40	50	50	40	40	40	25	25
22.5	55	70	70	60	60	60	50	35
20.0	75	90	85	80	90	90	55	30
17.5	100	130	130	120	120	85	40	15
15.0	160	170	165	130	125	70	20	10
12.5	150	140	110	105	110	55	10	10
10.0	105	85	70	70	70	25	5	10
7.5	70	55	40	40	40	15	5	10
5.0	30	15	15	20	20	15	15	15
2.5	20	15	20	20	20	15	15	15

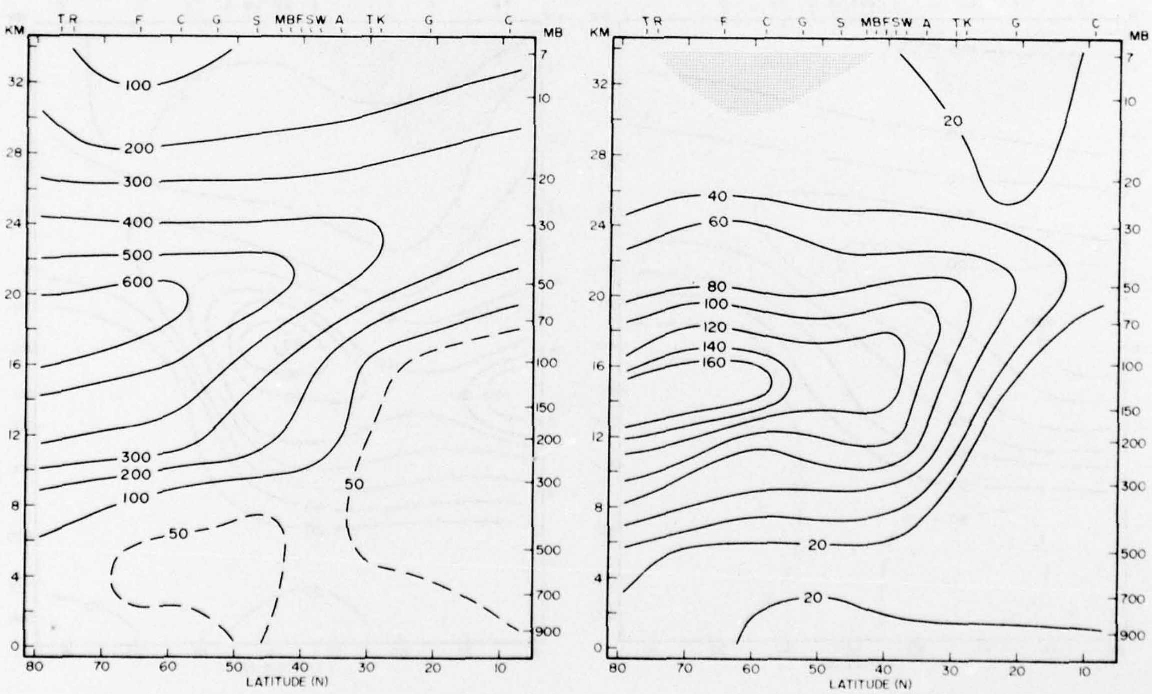


Figure 4 (cont'd).

<u>APRIL</u>

<u>$\mu g\ m^{-3}$</u>

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	130	130	130	140	140	150	160	170
30.0	160	160	170	180	200	220	240	250
27.5	220	220	230	260	280	300	310	320
25.0	330	320	330	360	380	370	370	370
22.5	470	460	460	450	440	400	370	320
20.0	550	550	540	470	410	300	240	170
17.5	570	570	540	400	290	140	60	50
15.0	520	520	500	330	220	80	40	25
12.5	460	430	400	270	170	50	35	25
10.0	370	280	220	170	110	40	35	30
7.5	180	120	80	70	60	45	35	35
5.0	60	50	45	50	55	50	50	40
2.5	55	50	50	60	65	65	55	55

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	20	20	20	20	15	15	10	20
30.0	25	25	25	25	20	20	20	25
27.5	30	35	35	35	30	25	30	30
25.0	35	40	45	40	35	35	35	40
22.5	40	50	50	55	50	45	45	45
20.0	60	65	65	70	80	65	50	35
17.5	100	95	105	110	105	65	35	20
15.0	140	165	160	145	140	50	25	10
12.5	115	135	165	140	130	35	15	10
10.0	95	110	130	125	80	20	10	15
7.5	70	70	75	70	35	15	15	15
5.0	20	15	20	25	25	15	20	20
2.5	15	15	15	25	25	20	20	25

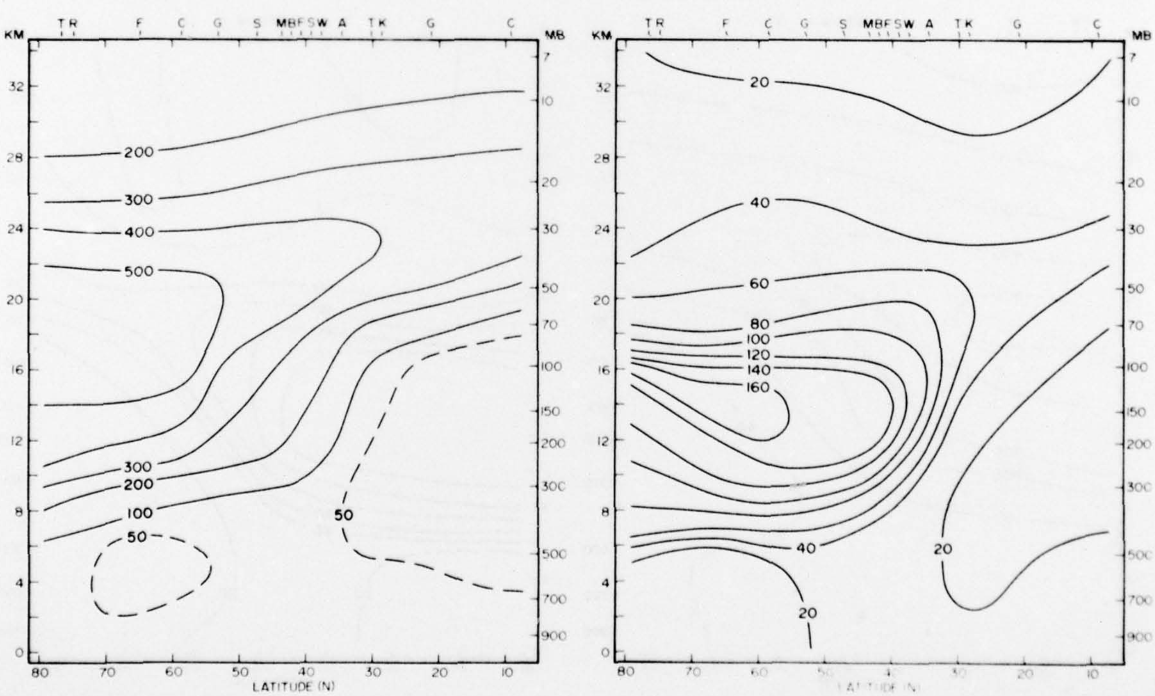


Figure 4 (cont'd).

MAY

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	100	80	90	120	140	160	160	170
30.0	150	140	160	180	200	210	230	250
27.5	190	200	220	260	280	300	320	340
25.0	270	280	300	330	360	370	370	370
22.5	360	380	400	420	410	380	360	320
20.0	470	500	500	450	380	300	230	200
17.5	520	510	500	400	270	160	100	50
15.0	440	430	390	330	200	100	50	25
12.5	370	360	330	270	160	70	40	25
10.0	310	250	210	180	80	50	40	25
7.5	130	120	100	80	60	45	40	25
5.0	60	60	55	60	60	55	50	35
2.5	60	55	55	70	70	70	60	35

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	30	20	15	20	25	25	15	30
30.0	30	20	15	25	30	25	15	35
27.5	30	30	30	30	30	25	20	40
25.0	35	40	40	40	35	25	25	45
22.5	45	50	50	50	40	45	45	55
20.0	60	55	60	65	70	65	60	65
17.5	90	90	100	105	100	80	50	30
15.0	125	125	130	130	105	70	30	10
12.5	125	125	125	125	100	35	15	10
10.0	120	120	120	110	70	20	15	10
7.5	90	85	75	65	35	15	15	15
5.0	20	20	20	25	25	15	15	20
2.5	15	15	15	25	25	15	15	15

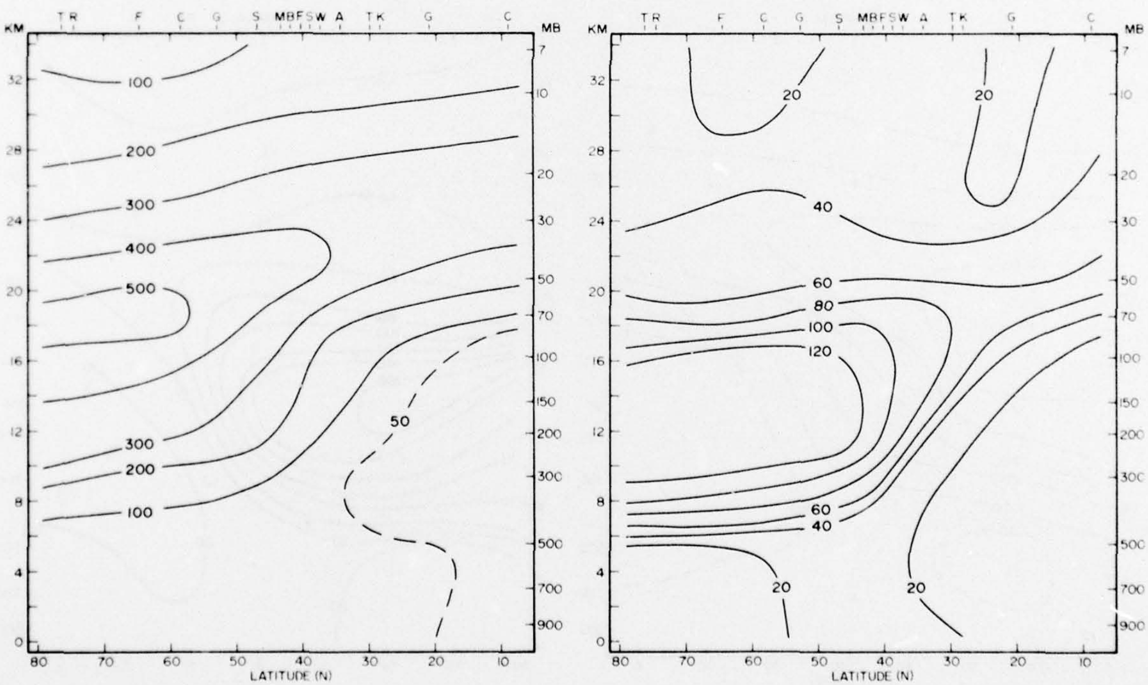


Figure 4 (cont'd).

JUNE

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	120	110	110	130	160	170	150	140
30.0	160	170	180	200	220	220	220	210
27.5	200	220	250	280	310	320	320	320
25.0	270	280	310	350	370	380	370	350
22.5	360	380	400	420	420	370	330	300
20.0	440	450	450	430	350	280	230	200
17.5	410	410	420	350	250	170	110	80
15.0	330	340	340	270	150	80	60	30
12.5	260	270	260	200	100	60	45	20
10.0	190	180	150	100	60	50	45	20
7.5	90	70	60	60	60	60	55	25
5.0	70	60	55	60	60	65	60	30
2.5	50	50	55	60	65	65	50	35

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	15	15	15	15	25	25	15	20
30.0	20	20	15	20	25	20	15	25
27.5	40	40	30	30	30	20	15	35
25.0	45	45	45	40	35	25	20	35
22.5	50	50	50	50	45	40	30	30
20.0	50	55	55	55	55	50	35	30
17.5	55	55	60	75	70	65	40	20
15.0	60	65	90	120	75	65	40	15
12.5	70	90	125	125	70	40	20	10
10.0	100	110	120	90	35	20	20	10
7.5	80	60	50	30	25	15	20	10
5.0	20	20	15	20	25	20	20	10
2.5	15	15	15	20	25	25	20	10

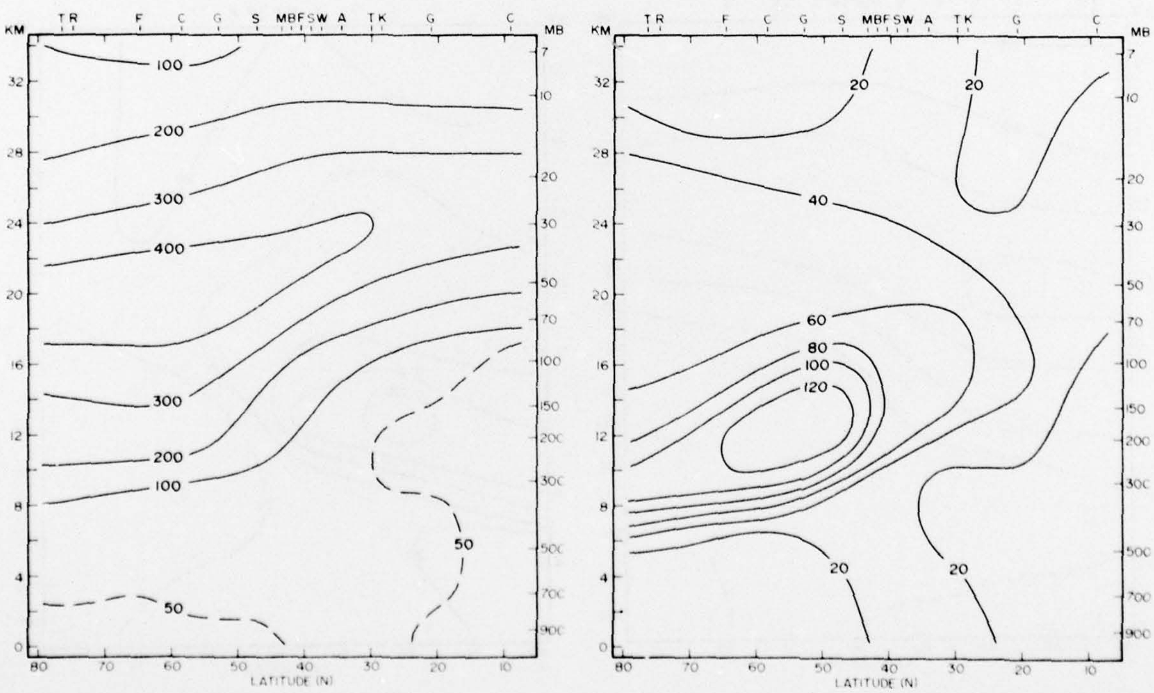


Figure 4 (cont'd).

JULY

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	120	120	120	150	160	160	150	140
30.0	150	170	180	210	230	230	220	210
27.5	180	210	240	270	310	320	310	310
25.0	250	270	290	320	350	370	360	340
22.5	320	350	360	370	380	360	330	300
20.0	390	420	410	370	320	260	220	210
17.5	400	390	390	300	200	140	110	80
15.0	320	310	290	200	100	70	50	40
12.5	250	240	230	140	80	45	40	25
10.0	170	140	120	80	60	50	40	25
7.5	100	80	70	60	65	60	50	30
5.0	60	55	55	60	65	55	55	35
2.5	40	45	50	55	70	55	50	30

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	20	15	15	20	20	15	15	25
30.0	25	20	20	25	25	20	15	30
27.5	30	30	35	35	30	20	15	35
25.0	35	35	45	45	35	25	15	30
22.5	40	40	50	45	35	30	20	30
20.0	45	50	50	50	45	35	35	40
17.5	50	55	55	60	50	40	30	20
15.0	60	60	80	75	60	30	20	15
12.5	75	85	105	90	60	20	15	15
10.0	90	85	80	60	30	20	15	15
7.5	80	55	40	35	20	15	15	15
5.0	15	15	20	25	20	20	20	15
2.5	15	15	25	25	25	20	20	15

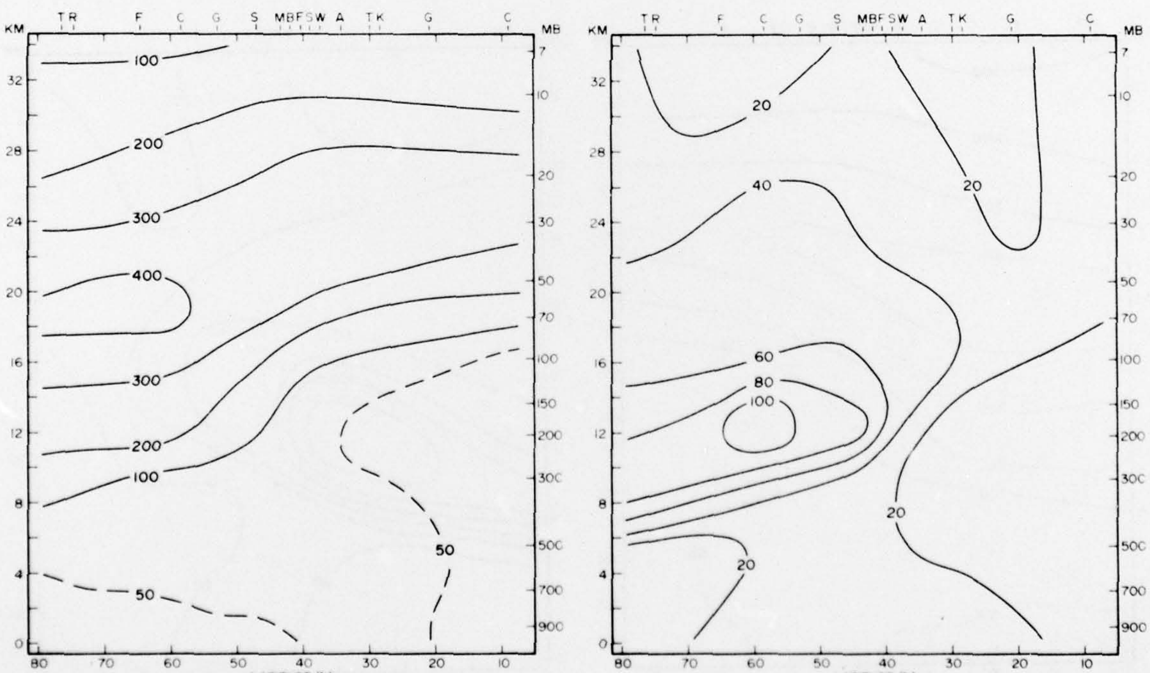


Figure 4 (cont'd).

AUGUST

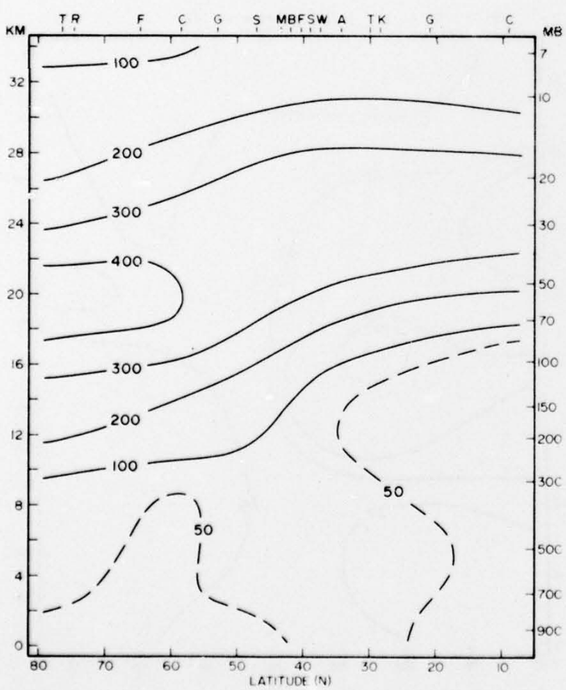
$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	110	110	120	150	160	160	150	140
30.0	150	160	180	200	230	240	230	220
27.5	180	200	250	280	310	320	320	320
25.0	260	280	310	330	360	360	360	360
22.5	360	370	360	370	380	340	320	310
20.0	430	430	410	370	300	250	210	200
17.5	400	390	350	280	200	140	100	60
15.0	300	280	250	180	110	60	45	25
12.5	230	200	170	130	70	40	35	20
10.0	130	100	80	70	60	50	35	25
7.5	80	70	45	55	55	60	50	25
5.0	55	50	45	55	60	65	55	30
2.5	50	45	45	50	70	80	50	25

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	15	15	15	15	20	15	15	15
30.0	20	15	15	20	25	20	15	15
27.5	30	30	30	30	25	20	15	15
25.0	45	45	45	45	30	40	30	30
22.5	50	50	60	50	40	40	45	50
20.0	55	55	60	55	45	35	35	30
17.5	60	55	60	60	45	30	25	15
15.0	60	55	60	85	45	30	20	5
12.5	50	50	55	85	40	20	15	5
10.0	45	40	40	60	35	20	15	10
7.5	25	20	25	30	25	15	15	10
5.0	15	15	15	20	20	20	15	10
2.5	15	15	15	20	25	25	20	15



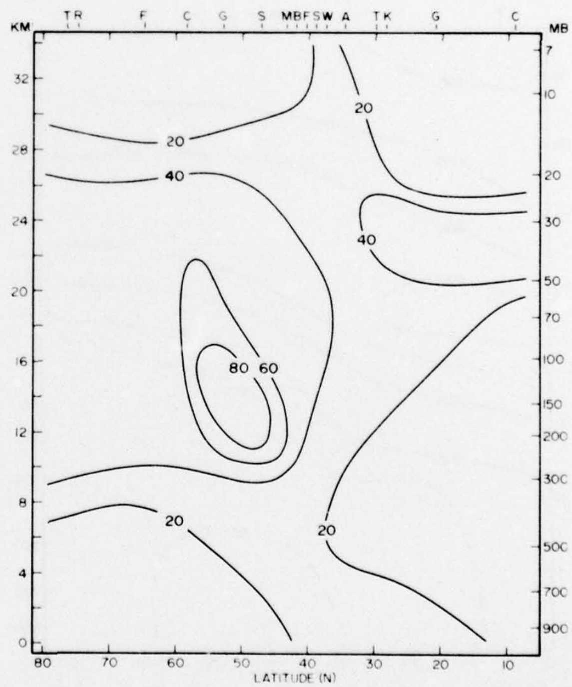


Figure 4 (cont'd).

SEPTEMBER

$\mu g \ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	80	80	100	130	150	150	150	170
30.0	120	130	160	180	200	220	230	240
27.5	170	180	230	260	290	310	310	310
25.0	190	250	280	330	350	360	360	350
22.5	270	320	340	380	380	340	310	290
20.0	370	410	400	360	300	230	200	180
17.5	420	410	390	300	170	120	80	60
15.0	330	280	240	170	80	50	45	30
12.5	200	170	150	120	50	35	35	25
10.0	120	100	70	60	40	40	35	25
7.5	70	55	45	45	40	45	40	30
5.0	55	50	40	40	50	55	45	35
2.5	55	50	45	45	60	65	45	40

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	25	20	15	15	15	15	10	20
30.0	30	25	20	20	20	15	10	20
27.5	50	40	35	35	30	20	15	30
25.0	70	60	50	45	35	25	15	35
22.5	65	60	55	50	35	30	20	40
20.0	60	55	50	55	40	30	35	45
17.5	55	55	80	70	40	30	20	20
15.0	65	70	80	75	40	20	15	10
12.5	50	60	65	65	35	15	15	5
10.0	45	45	45	45	25	15	15	5
7.5	25	20	20	25	25	15	15	5
5.0	15	15	15	20	25	15	15	10
2.5	15	15	15	20	25	20	15	10

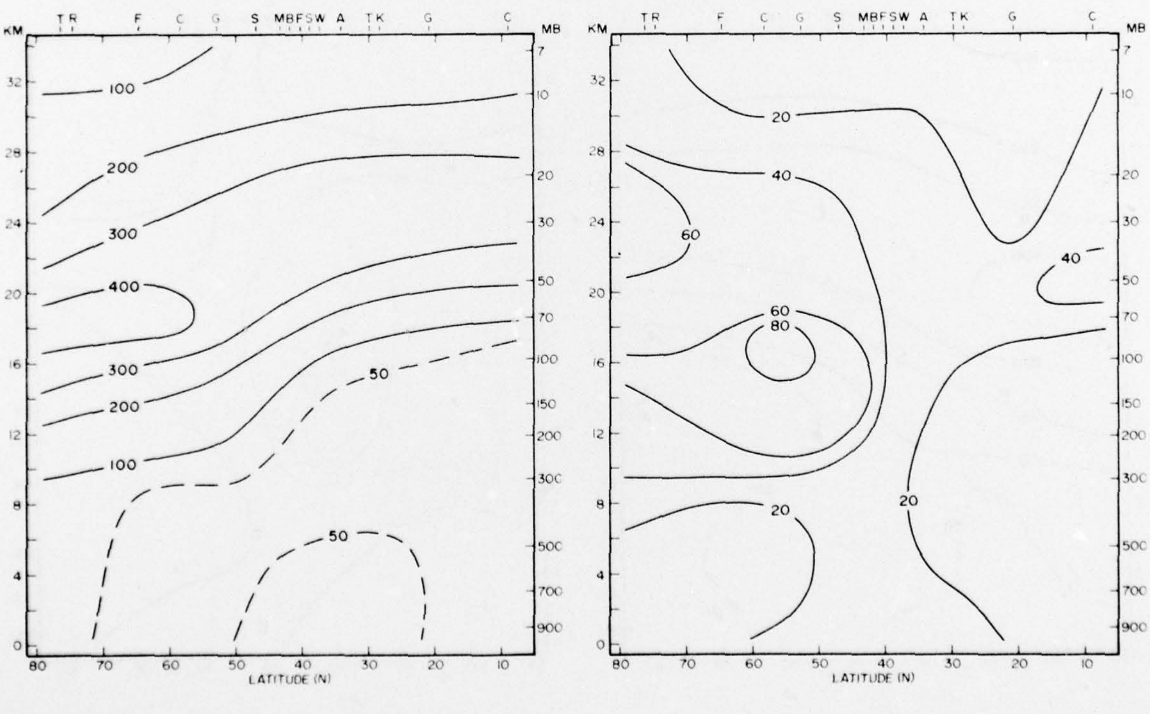


Figure 4 (cont'd).

<u>OCTOBER</u>

<u>$\mu g\ m^{-3}$</u>

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	80	90	110	130	140	160	150	150
30.0	130	150	170	180	200	220	230	230
27.5	200	220	240	260	280	300	310	310
25.0	280	290	310	330	340	370	350	340
22.5	350	350	350	360	360	360	320	280
20.0	420	420	390	350	310	240	190	160
17.5	440	420	410	300	190	120	80	50
15.0	320	320	300	200	100	50	30	25
12.5	220	210	200	120	60	35	20	20
10.0	130	130	110	60	45	30	25	25
7.5	70	60	55	40	40	30	30	30
5.0	55	55	55	35	50	40	35	25
2.5	55	55	55	40	60	50	35	35

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	20	15	15	25	20	15	10	25
30.0	40	20	20	30	25	15	15	25
27.5	50	45	35	35	30	20	20	35
25.0	60	50	45	40	35	25	40	45
22.5	65	55	50	45	40	30	40	45
20.0	70	60	55	55	50	35	35	30
17.5	80	80	80	85	70	35	20	20
15.0	75	85	90	90	60	20	15	10
12.5	60	75	80	75	50	15	10	10
10.0	50	50	55	50	30	15	10	10
7.5	30	30	35	35	25	15	10	10
5.0	15	15	25	25	25	10	10	15
2.5	15	15	20	20	25	20	15	15

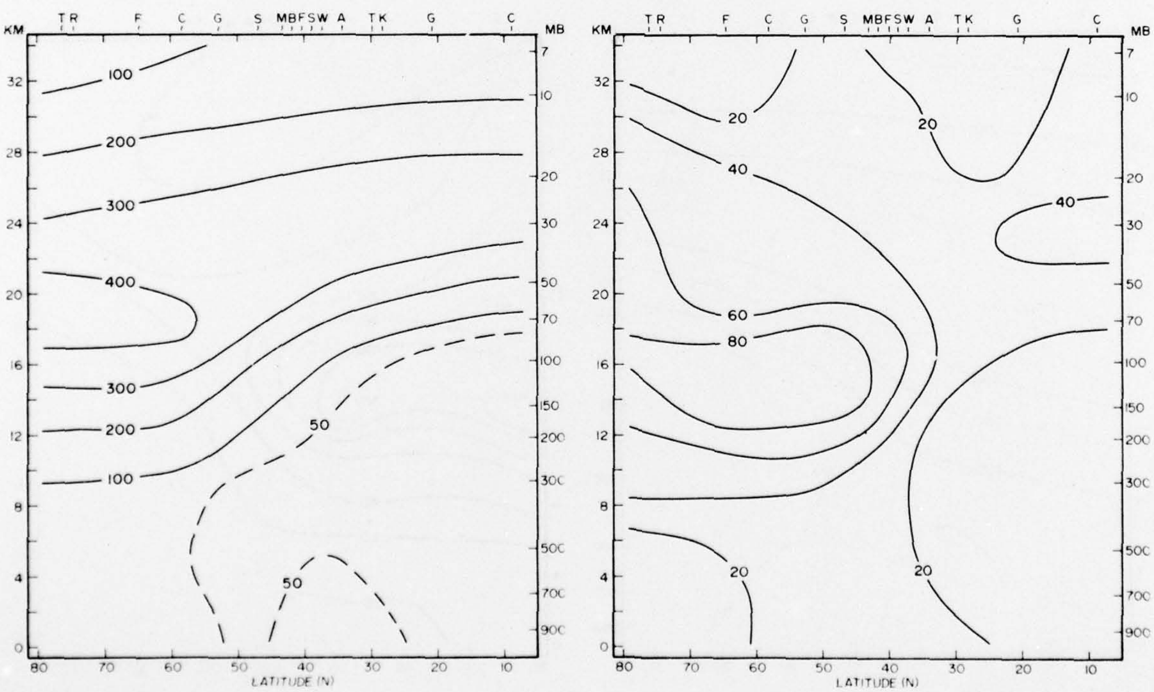


Figure 4 (cont'd).

NOVEMBER

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	90	100	110	120	140	160	160	160
30.0	160	170	180	190	210	220	220	220
27.5	220	240	260	270	290	310	320	340
25.0	280	310	330	370	350	350	350	400
22.5	360	380	370	410	370	350	320	270
20.0	440	420	380	370	320	260	200	130
17.5	480	420	360	320	230	140	70	50
15.0	410	340	300	230	130	60	30	20
12.5	270	230	200	150	70	40	20	20
10.0	170	140	110	80	60	30	25	20
7.5	90	80	70	60	55	35	30	20
5.0	60	55	50	45	55	55	35	20
2.5	55	50	45	40	65	55	45	25

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	40	20	15	15	15	20	25	25
30.0	50	40	25	15	15	15	25	25
27.5	60	45	30	25	20	20	20	25
25.0	65	50	35	35	30	25	30	35
22.5	70	60	50	40	35	35	35	45
20.0	75	70	60	60	50	45	40	30
17.5	80	80	90	90	70	50	30	20
15.0	110	110	110	110	70	30	10	10
12.5	125	85	80	100	50	20	5	10
10.0	70	50	50	55	35	15	5	5
7.5	40	35	35	30	20	10	10	10
5.0	20	20	20	15	20	10	15	10
2.5	15	15	20	20	20	10	15	10

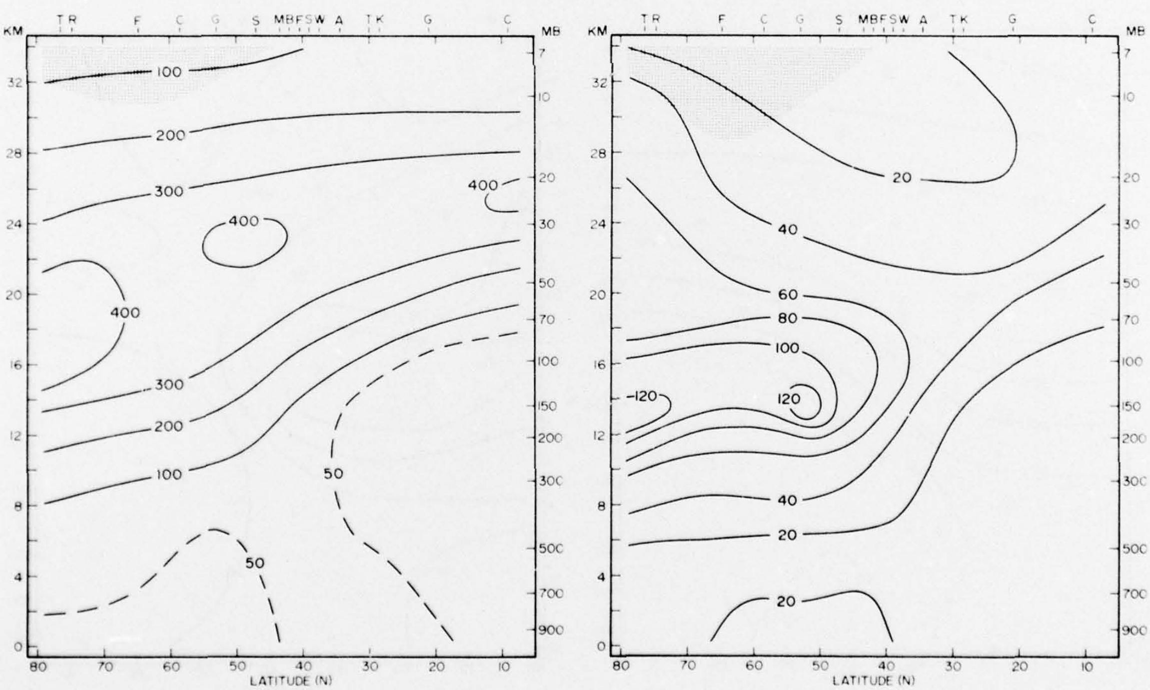


Figure 4 (cont'd).

DECEMBER

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	100	100	100	120	130	140	160	170
30.0	140	160	180	180	180	200	230	250
27.5	220	250	260	270	290	300	310	310
25.0	300	330	360	380	400	370	370	360
22.5	380	430	460	450	420	400	330	280
20.0	460	480	520	430	370	290	210	140
17.5	520	510	450	350	270	150	80	50
15.0	420	420	370	270	170	60	30	20
12.5	290	290	230	170	100	50	20	20
10.0	160	150	120	100	70	40	20	20
7.5	70	60	55	55	55	40	25	25
5.0	55	55	45	50	55	40	30	25
2.5	55	55	45	40	50	50	40	30

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	10	15	15	15	15	15	25	25
30.0	15	20	25	25	20	25	25	30
27.5	35	40	35	30	30	30	25	25
25.0	50	60	55	40	35	35	25	25
22.5	65	70	70	65	55	40	25	30
20.0	75	75	75	75	70	60	45	35
17.5	80	90	100	100	100	75	45	15
15.0	105	110	110	125	120	55	10	5
12.5	100	100	90	85	75	25	10	5
10.0	55	50	50	55	45	15	10	5
7.5	40	25	20	25	30	15	10	10
5.0	15	15	20	15	25	15	15	10
2.5	15	15	20	15	20	20	15	10

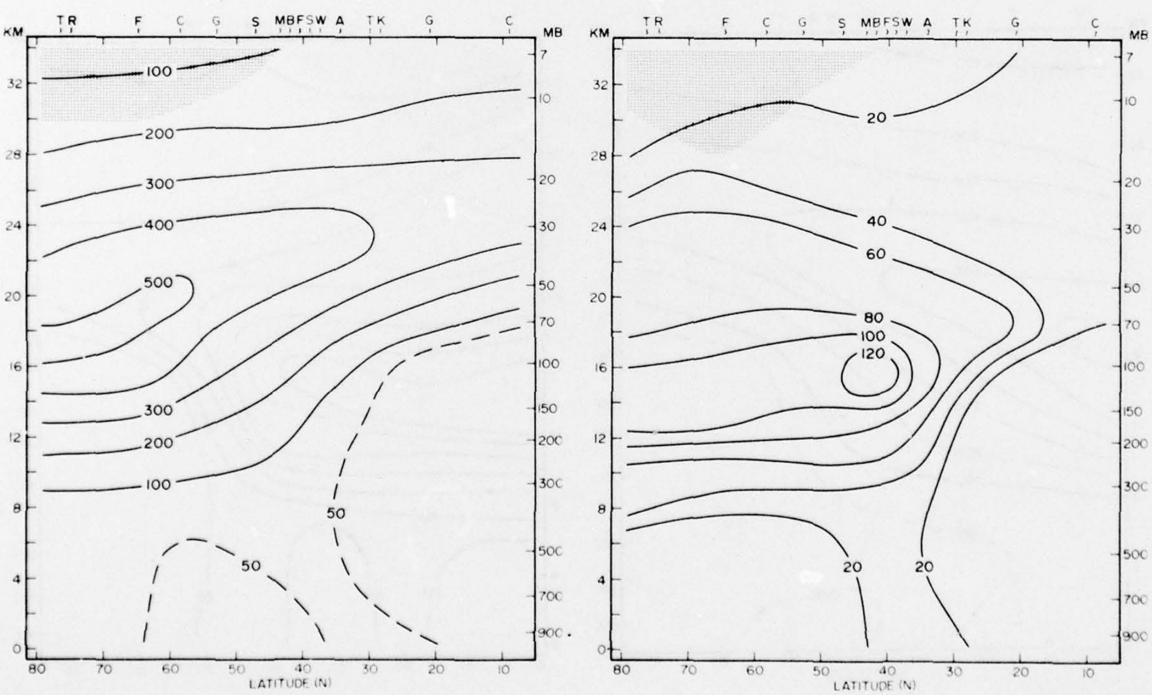


Figure 4 (cont'd).

DECEMBER - FEBRUARY

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	100	100	100	120	130	140	150	160
30.0	160	140	150	170	180	200	230	250
27.5	180	210	240	270	290	310	320	330
25.0	300	330	360	370	380	380	370	360
22.5	400	430	450	460	460	420	340	280
20.0	510	520	530	520	430	290	200	150
17.5	610	580	510	420	300	160	70	50
15.0	590	510	400	300	190	70	30	20
12.5	500	380	290	220	130	50	20	15
10.0	300	210	180	130	80	35	20	20
7.5	90	80	70	60	50	35	25	20
5.0	55	55	50	40	45	40	30	25
2.5	55	55	50	40	50	50	40	30

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	25	15	15	15	20	20	25	20
30.0	50	35	30	25	25	30	25	25
27.5	65	60	40	35	35	35	30	30
25.0	70	70	60	50	40	40	35	35
22.5	80	75	70	65	60	50	50	50
20.0	90	90	85	85	90	80	60	45
17.5	120	115	110	120	120	80	40	20
15.0	145	140	140	145	130	55	10	10
12.5	145	140	130	115	105	30	10	5
10.0	85	80	80	80	65	20	10	5
7.5	45	40	40	30	30	20	10	10
5.0	20	15	20	15	20	20	10	10
2.5	10	10	25	15	20	20	15	10

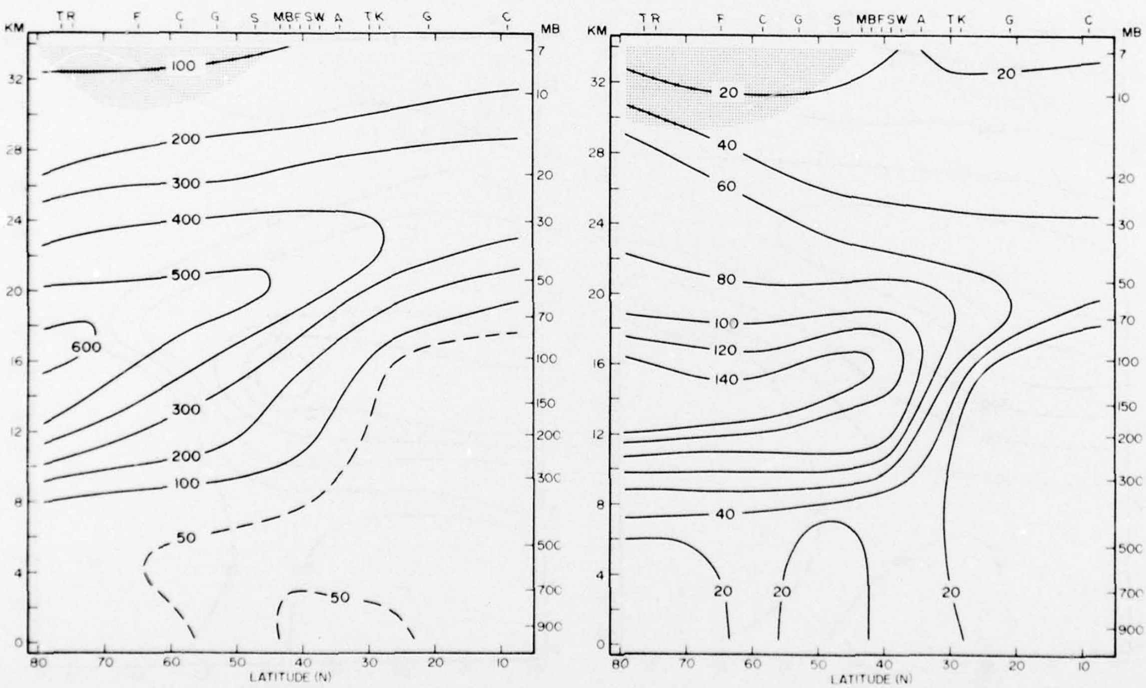


Figure 5. Seasonal height-latitude corss-sections of ozone means and standard deviations near 80°W in units micrograms per cubic meter. Shaded areas have no data. The pressure scale is approximate, based on the annual mid-latitude average.

MARCH - MAY

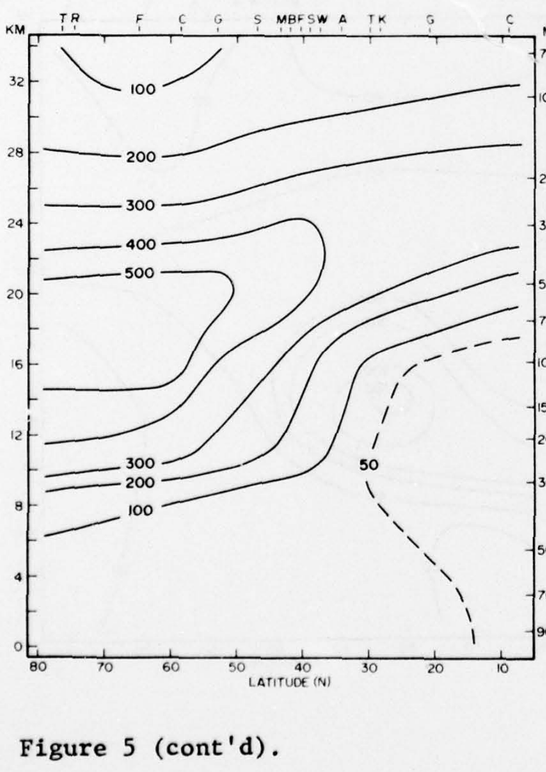
$\mu g\ m^{-3}$

MEANS

KM	80N	70	60	50	40	30	20	10
32.5	120	80	90	130	150	150	150	170
30.0	170	150	150	180	200	210	230	260
27.5	220	220	210	250	280	300	320	330
25.0	300	300	300	340	370	370	370	380
22.5	400	410	430	440	430	370	340	290
20.0	520	530	530	490	410	310	210	150
17.5	570	560	540	410	300	150	90	50
15.0	510	510	500	340	210	80	45	20
12.5	430	420	370	280	170	60	35	20
10.0	320	290	250	180	110	50	35	25
7.5	160	120	90	80	70	50	40	30
5.0	70	60	55	55	60	60	50	35
2.5	55	55	55	55	70	70	60	45

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	30	25	15	20	25	25	15	30
30.0	35	30	30	30	30	25	15	35
27.5	45	45	40	35	35	30	25	35
25.0	60	55	50	50	40	35	35	45
22.5	70	65	60	60	55	50	40	50
20.0	85	85	85	85	85	80	55	45
17.5	115	115	110	120	105	80	45	25
15.0	160	150	160	130	110	70	20	10
12.5	140	130	130	125	105	40	15	10
10.0	105	105	105	105	75	20	15	15
7.5	70	70	65	65	40	15	15	15
5.0	20	20	20	25	25	15	15	20
2.5	15	15	20	25	25	20	20	25



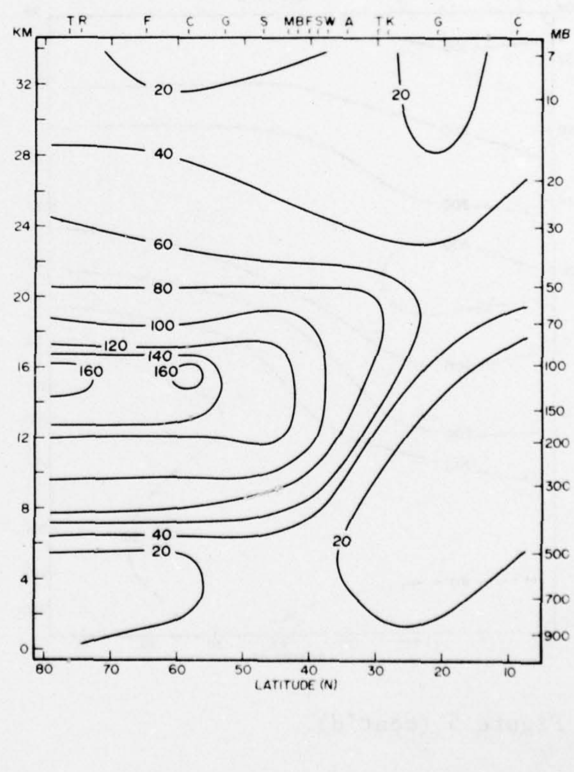


Figure 5 (cont'd).

JUNE - AUGUST

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	120	110	110	150	160	160	160	150
30.0	150	160	170	200	220	230	220	220
27.5	180	210	230	270	310	320	330	330
25.0	250	270	290	330	370	370	360	350
22.5	320	350	370	360	360	350	320	300
20.0	400	430	430	360	330	260	220	200
17.5	370	380	400	310	200	130	100	80
15.0	290	310	300	220	120	80	60	35
12.5	250	250	240	160	80	50	40	20
10.0	180	170	130	90	60	50	40	25
7.5	90	80	65	65	60	55	50	25
5.0	55	55	55	60	65	65	60	30
2.5	50	50	50	60	75	65	55	30

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	15	15	15	15	20	15	15	20
30.0	25	20	20	20	25	20	15	25
27.5	35	35	35	35	30	25	20	35
25.0	40	45	50	50	40	30	25	35
22.5	50	50	55	50	45	45	40	35
20.0	50	55	55	55	50	45	45	40
17.5	50	55	75	80	55	45	35	25
15.0	55	60	100	90	60	35	30	15
12.5	60	65	120	105	60	30	20	10
10.0	80	85	95	60	40	25	20	10
7.5	60	50	45	35	25	25	20	10
5.0	20	20	25	25	20	20	20	10
2.5	15	15	25	25	25	30	25	10

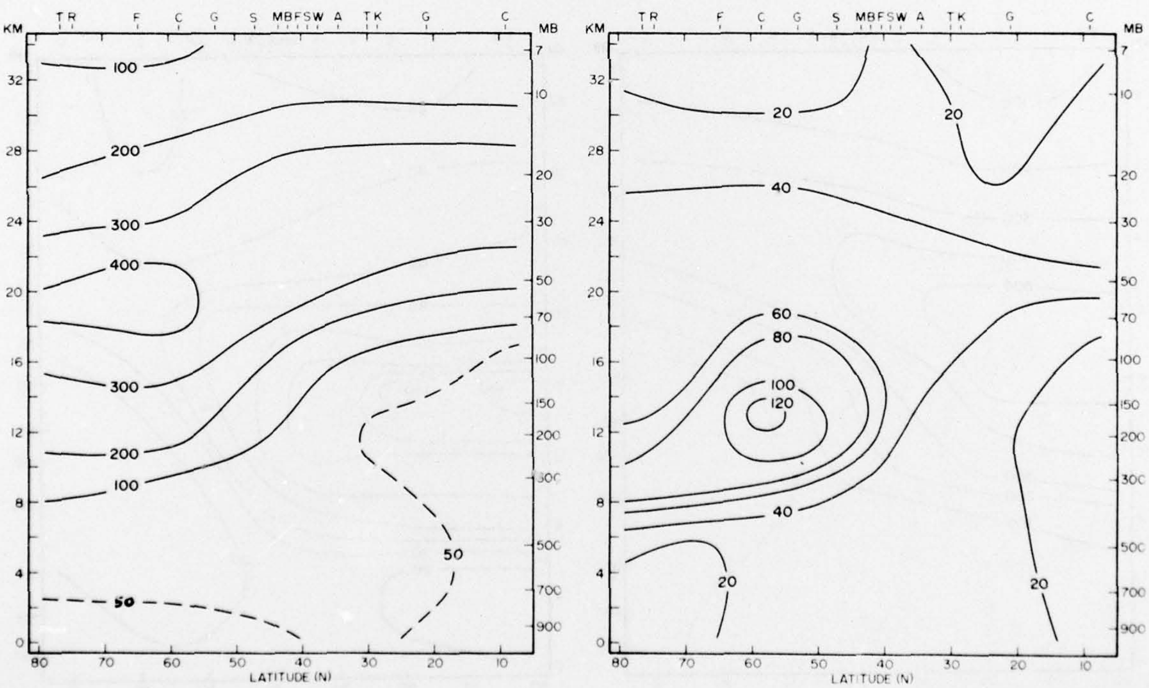


Figure 5 (cont'd).

SEPTEMBER - NOVEMBER

$\mu g\ m^{-3}$

MEAN

KM	80N	70	60	50	40	30	20	10
32.5	70	80	100	130	140	150	150	150
30.0	130	140	150	180	200	210	220	220
27.5	180	200	210	260	300	310	320	330
25.0	250	270	290	340	350	360	350	350
22.5	340	340	340	370	370	350	310	300
20.0	420	410	390	370	320	240	190	150
17.5	440	430	400	300	200	120	80	50
15.0	370	320	290	200	110	50	35	25
12.5	250	210	200	130	70	35	25	20
10.0	130	120	110	80	50	35	25	25
7.5	70	70	55	45	45	40	30	25
5.0	55	55	45	40	55	45	40	30
2.5	50	45	45	45	60	55	40	30

STANDARD DEVIATION

KM	80N	70	60	50	40	30	20	10
32.5	20	25	25	25	20	15	15	25
30.0	45	40	30	30	25	20	25	30
27.5	65	50	45	35	30	25	25	35
25.0	85	70	60	45	35	30	30	45
22.5	85	70	60	50	40	30	35	45
20.0	70	70	60	55	50	40	35	40
17.5	85	75	85	80	60	40	25	20
15.0	90	95	95	90	60	30	15	10
12.5	80	80	80	70	40	15	10	10
10.0	50	50	55	45	30	15	10	10
7.5	40	35	30	25	25	15	15	10
5.0	20	20	20	15	25	15	15	15
2.5	15	15	20	20	25	20	15	15

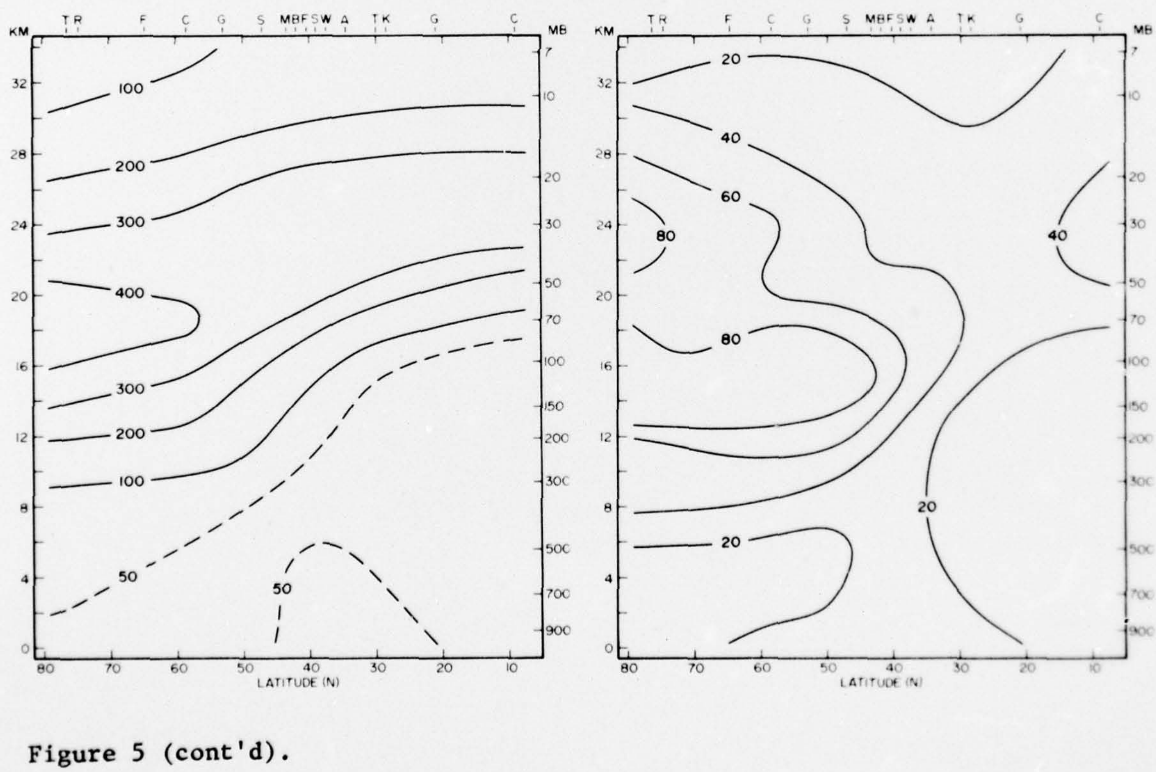


Figure 5 (cont'd).